NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

FUTURE REQUIREMENTS OF THE NAVY/NOAA
OCEANOGRAPHIC DATA DISTRIBUTION SYSTEM

by

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March 1986

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* Future Requirements of the Navy/NOAA Oceanographic Data Distribution System		5. TYPE OF REPORT & PERIOD COVERED Master's thesis; March 1986 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR*(s)* Paul Michael Duernberger		8. CONTRACT OR GRANT NUMBER*(s)*
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, CA 93943-5000		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, CA 93943-5000		12. REPORT DATE March 1986 13. NUMBER OF PAGES 93
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Navy/NOAA Oceanographic Data Distribution System; Navy Oceanographic Data Distribution System; SEASAT Data Distribution System

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The Navy/NOAA Oceanographic Data Distribution System (NODDS) is described and its history is traced from the system's inception in 1979. NODDS allows both government and commercial users to access unclassified oceanographic and meteorological data and/or products from the Fleet Numerical Oceanography Center (FNOC). The available data and products are reviewed. The system is currently based on a PDP 11 computer which

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S N 0102-LF-014-6601

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

Block 20 Contd.

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Future Requirements of the Navy/NOAA Oceanographic Data Distribution System

by

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Submitted in partial fulfillment of the
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MASTER OF SCIENCE IN APPLIED SCIENCE

from the

NAVAL POSTGRADUATE SCHOOL
March 1986

ABSTRACT

The Navy/NOAA Oceanographic Data Distribution System (NODDS) is described and its history is traced from the system's inception in 1979. NODDS allows both government and commercial users to access unclassified oceanographic and meteorological data and/or products from the Fleet Numerical Oceanography Center (FNOC). The available data and products are reviewed. The system is currently based on a PDP 11 computer which acquires FNOC products and data from the FNOC mainframe computers. The users access their directories through the TYMNET communications network. At the present time, the system has more than 40 users. Various system expansion issues are reviewed and various options for expansion are discussed. A three to five year expansion option is recommended.

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I. INTRODUCTION

Numerous advances in remote sensing using various satellites occurred during the 1970s. A very brief satellite demonstration program during the latter half of 1978 still has its effects today. The program has evolved from its initial research applications, to one of providing near real-time environmental data and products to users on a global basis.

As early as 1974, the National Aeronautics and Space Administration (NASA) was advertising the scientific contributions of the proposed SEASAT-A satellite. Tables 1 and 2 list the parameters and benefits expected from this satellite program. The SEASAT-A system was unique since its complete instrumentation was dedicated to various oceanic requirements and should have provided for an all-weather monitoring capability of the ocean surface by use of microwave instruments.

The National Oceanic and Atmospheric Administration (NOAA), NASA, and the Navy were different agencies eager to acquire this data and to apply it to their own environmental monitoring programs. Each of these user agencies had its own mission and operational need for the SEASAT data. With a limited distribution system, conflicts could have been expected. The ultimate objectives of the SEASAT program were to:

Table 1

Related Discipline	PHENOMENA OBSERVED								
	Ht.	Spec.	Imag.	Wind	Temp	Ice	Tide	Currents	Geoid
SEA-Air Interaction									
Wave generation	X	X	X	X					
Heat Transfer					X	X		X	
Sea Interactions									
Wave field	X	X	X						
Wave-Wave	X	X	X						
Internal Wave	X	X	X						
Wave Trapping	X	X	X					X	
Refraction	X	X	X					X	
Sea-Coast Interaction									
Refraction	X	X	X						
Diffraction	X	X	X						
Planetary Oceanography									
Circulations								X	
Boundary Currents					X			X	
Mid-Ocean Currents								X	
Inter-Hemisphere								X	
Ice Fields						X			
Structure						X			
Dynamics									X

Table 1 (cont'd)

Related Discipline	HT.	Spec.	Imag.	Wind	Temp	Ice	Tide	Currents	Geoid
Solid Earth Physics									
Gravity Field									X
Lithosphere									
Structure							X		X
Dynamics							X		X
Ocean Rise							X		X
Volcanism							X		X
Continental Shelf							X	X	X
Subduction Zones							X		X
Margin Basins							X		X
The Asthenosphere									
Structure							X		X
Dynamics							X		X
Convective Cells							X		X
Meteorology									
Reference Surface				X					
Heat Transfer					X	X		X	
Fronts	X	X	X	X	X			X	
Storms	X	X	X					X	
Planetary Meteorology									
ITCZ	X	X	X	X	X			X	
Inter-Hemisphere	X	X	X	X	X			X	

Table 1 (cont'd)

Related Discipline	Ht.	Spec.	Imag.	Wind	Temp.	Ice	Tide	Currents	Geoid
Polar Regions									
Southern Ocean	X	X	X	X	X	X		X	
Climatology									
Reference Surface				X					
Heat Transfer					X	X			
Planetary									
ITCZ				X	X			X	
Inter Hemisphere				X	X			X	
Polar Region				X	X	X		X	
Southern Ocean				X	X	X		X	

(Ref. 11)

Parameters Observered from SEASAT and Their Uses

Table 2

BENEFITS FROM SEASAT DATA

General	Specific
Advancement of Knowledge	* Oceanographic, Meteorological, Geodetic, and Engineering
Protection of Life and Property	
Navigation and Safety	* Prediction of High Seas, Adverse Currents
	* Navigation through Ice fields
	* More precise Iceberg Warnings
	* Decrease loss of Men and Ships
Warning of Natural Hazards	* More accurate, Longer term Weather Forecasts
	* Improved Warnings of Storms
	* Decrease Tsunami False Alarms
Economic Benefits to the Nation	
Maritime Operations	* Optimum Ship Routing
	* Reduced Loss of Oil Rigs
	* Improved Design of Offshore Platforms
	* Improved Ship Design
	Improved Charting and Geodesy
Utilization of Resources	* Assessment of Biological Products
	* Location of Fisheries Areas
	* Aid in Oil and Mineral Locations
Environmental Impact	* Dispersal of Pollutants
	Improve Shoreline Protection
National Defense	* Improved Environmental Forecasts
	* More Precise Geoidal Model

(Ref 11)

a. Establish those environmental measurements and acquisition techniques that can be made from an operational system with efficiency and economy.

b. Establish the geoid of the earth to the accuracy needed to serve as a reference surface for sea-surface topography.

c. Continue to improve the understanding of the complex, dynamic behavior of the ocean and the sea-air interface.

d. Contribute to the improvement of major ongoing international, national, and NOAA programw with synoptic environmental data.

While these objectives are noteworthy, and probably were essential, no alternative plans were made for the distribution system if the satellite failed. This research will assess the evolution of this short lived satellite program, its continuing data distribution system, its lingering problems, and will propose various options with a recommendation for a three to five year expansion plan.

II. SYSTEM DESCRIPTION

The Navy/NOAA Oceanographic Data Distribution System (NODDS), formerly known as the SEASAT Data Distribution System (SDDS), provides a method for private industry and government agencies to access the U.S. Navy's Fleet Numerical Oceanography Center (FNOC) operational meteorological and oceanographic analyses and forecast charts. SDDS was originally established as a method for commercial users to receive SEASAT data in near real-time through the operational computer system located at FNOC. With the failure of SEASAT after only four months of operation in 1978, the distribution system substituted FNOC products, and the system has evolved into the present NODDS program.

Originally, NASA procured a PDP 11/60 computer which was delivered to FNOC in 1978 for use as the primary host computer for the distribution of the SEASAT data. In 1980, NASA transferred this computer to the Navy for the continued distribution of the FNOC products.

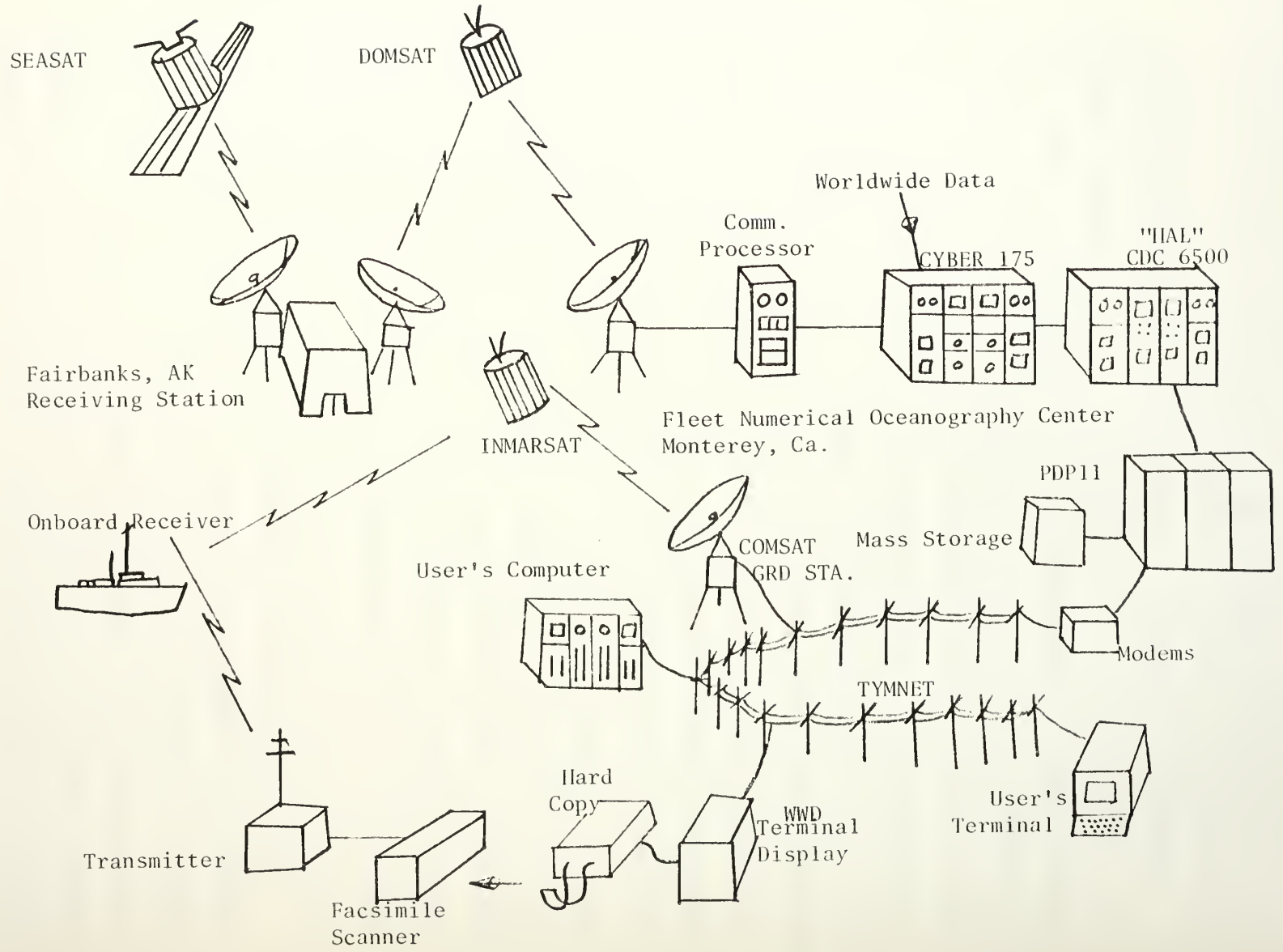
The system operates by using basic oceanographic and meteorological synoptic observations as input to the FNOC modeling programs which produce various analyzed fields and forecasts. The daily routine is separated into two, 12-hour periods. On the first watch, 00Z to 12Z, the meteorological forecasts are extended out to 120 hours. On the second watch,

12Z to 00Z, only forecasts to 72 hours after the observation time are produced. All the oceanographic products are only forecasted out to a 72 hour time period.

After the analysis and forecast products are produced, the computed data is transferred via a communication link to the host PDP 11/60 computer. The various users access the system via five TYMNET ports into the PDP 11/60. Figure A depicts the various elements of the NODDS program.

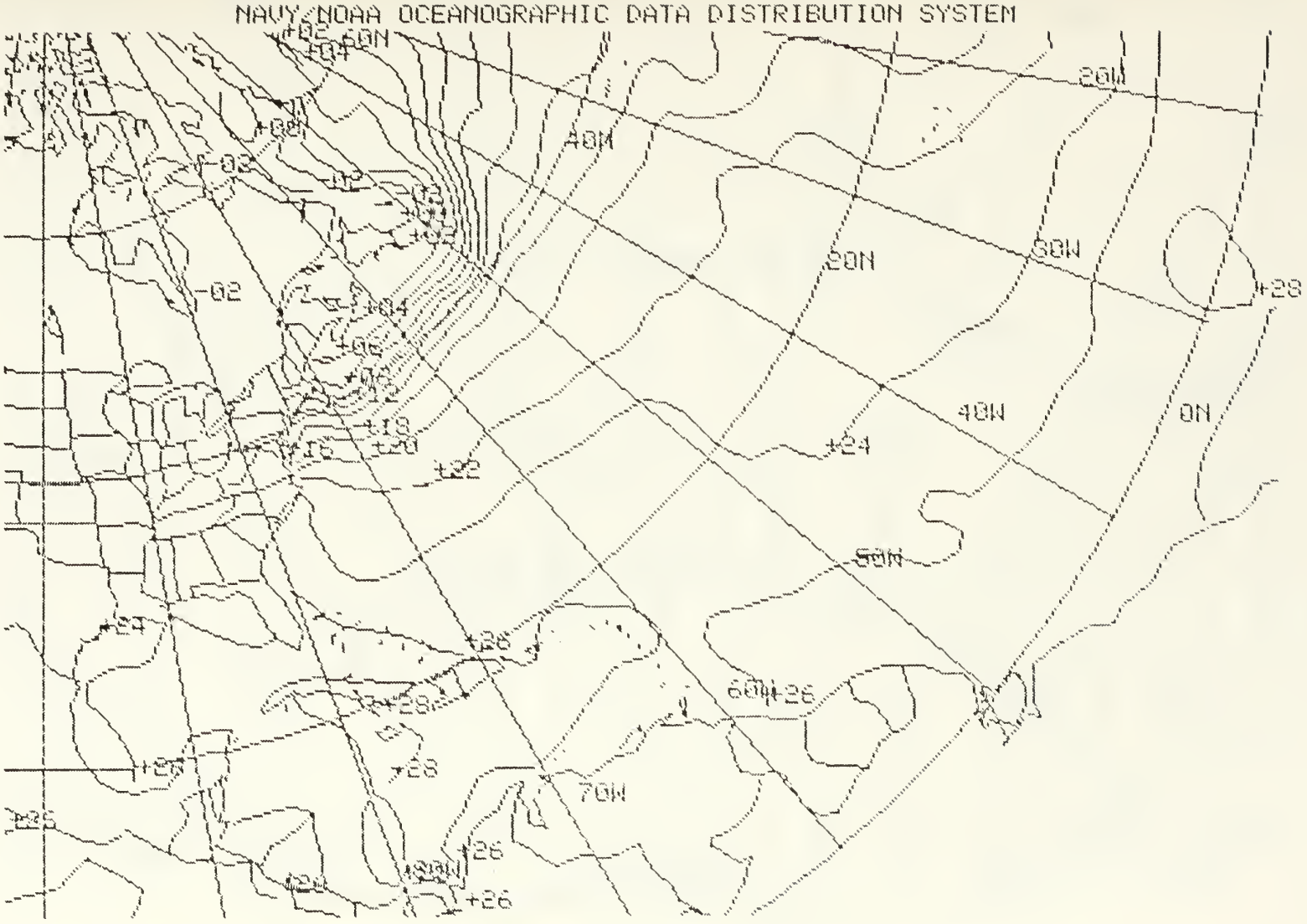
Unclassified FNOC products are available to the NODDS user in either alphanumeric, tabular, spectral, graphic, or binary format. In order to receive graphic products, the user must have a Tektronix terminal with a "Plot 10" software package or have a microcomputer with a "Plot 10" emmulator. Figures B and C are samples of this graphic product. The newest alphanumeric message is a plain language message generated by the Joint Ice Center, Suitland, MD, describing the ice limits for both the north and south polar regions. The tabular format used the terminal to display data of a certain area in an X-Y type coordinate system. The spectral data is a specific point location for wave data.

The various oceanographic products vary from the basic sea surface temperature charts, to sub-surface structure charts, to the spectral wave height and direction information. The meteorological charts indicate winds, temperatures, high and low pressure air masses and heights of various pressure fields from the surface to upper levels of the atmosphere.



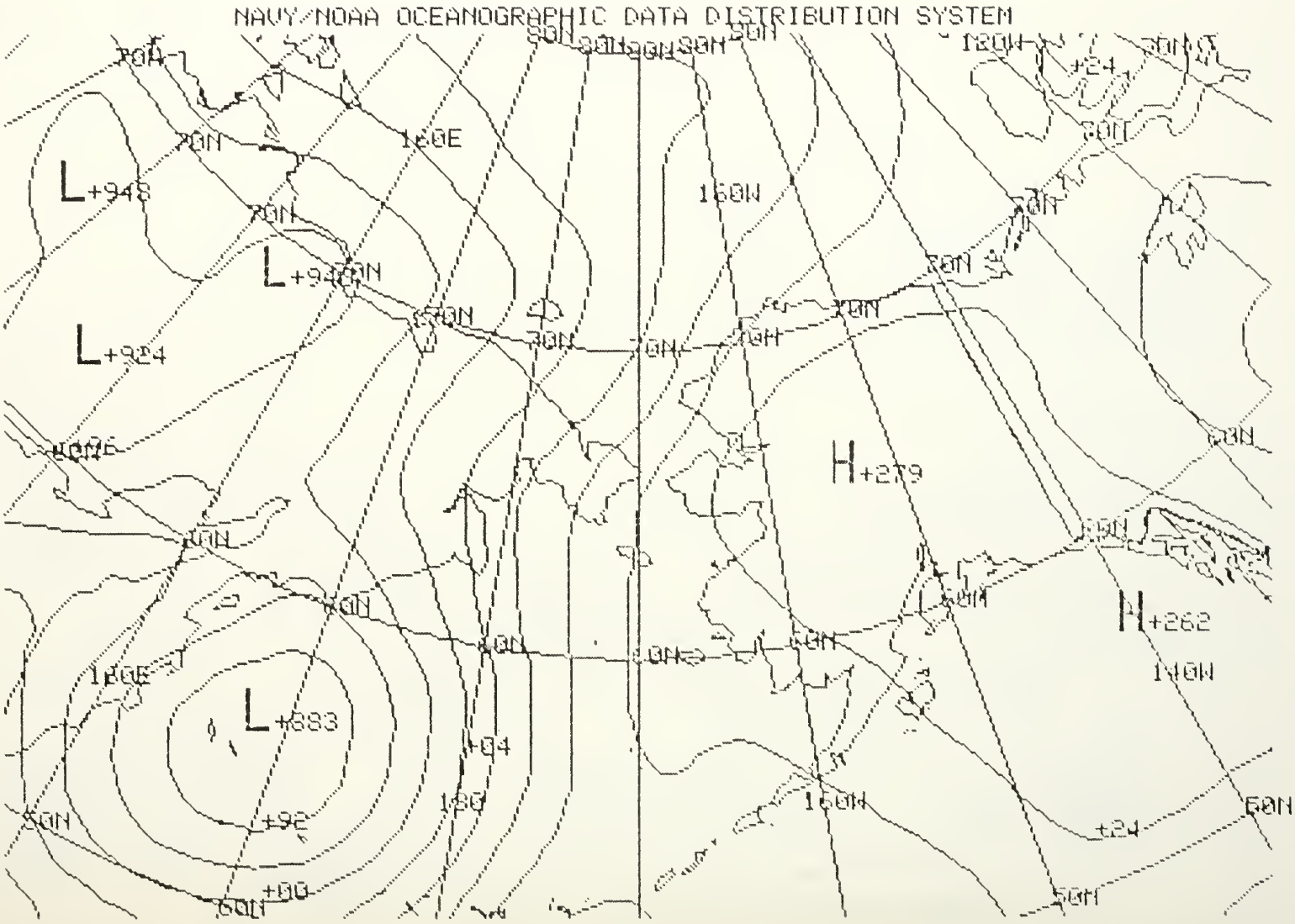
System Configuration

Figure A



NODDS Sea Surface Temperature Graphic

Figure B

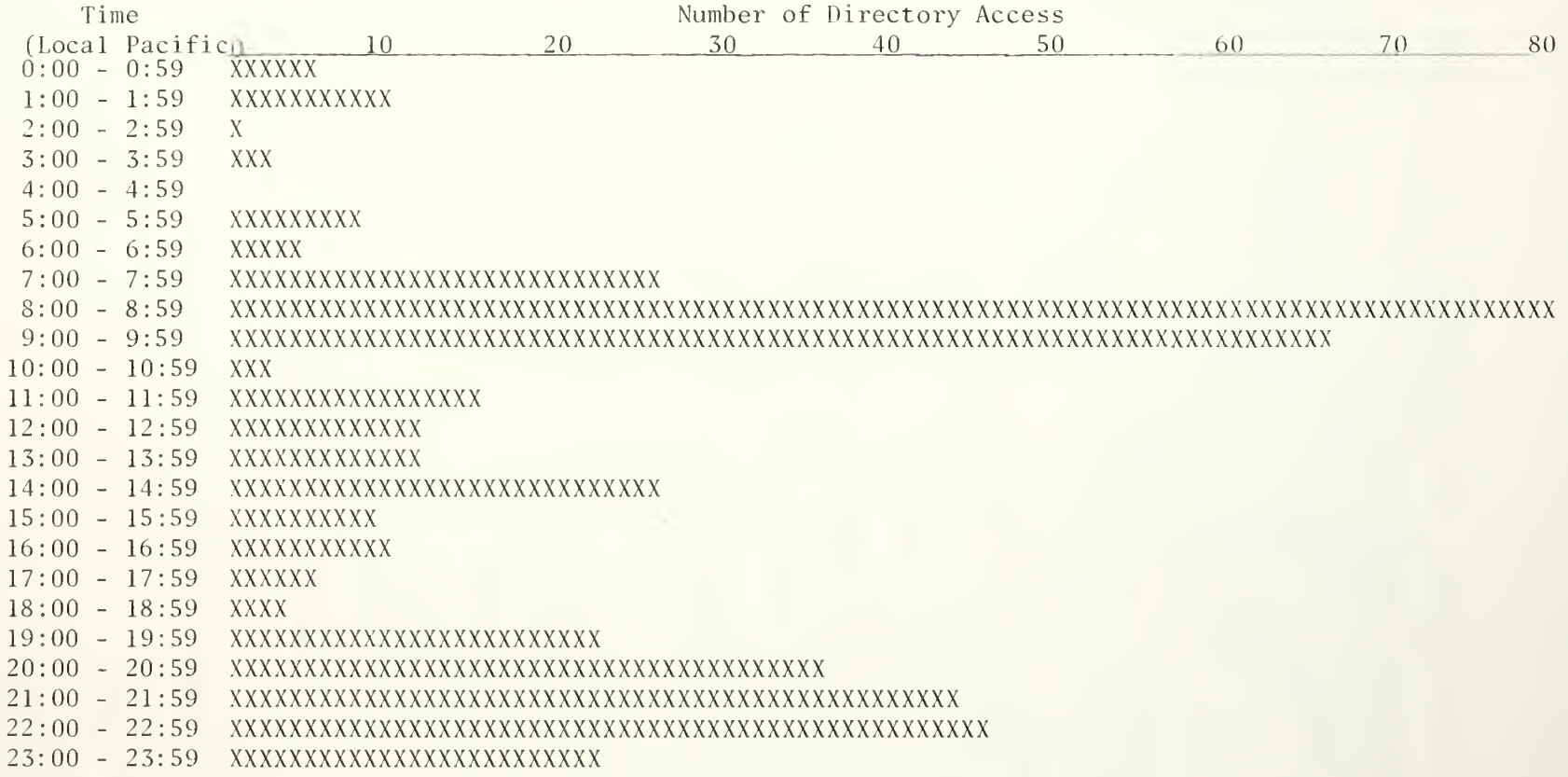


NODDS Surface Analysis Grpahic

To monitor and update the daily usage of the NODDS program, a NODDS Resident Manager is on duty during normal working hours and is "on call" after normal working hours. Currently, this system daily management is under contract to the Science Applications International Corporation (SAIC). Two resident managers rotate in bi-weekly shifts, with after normal working hours phone calls being coordinated by an answering service.

The monthly average connect time to the PDP 11/60 has increased since 1978. Currently, thirty-eight users access the system by using the TYMNET communications network. The daily usage graph, Figure D, indicates the two peak periods of the day. The major period is associated with the normal business cycle, with the east coast users logging on between 0700 to 0900 eastern time followed by the west coast users three hours later. The first peak usage period extends from 0600 to 1000 Pacific Time. The second peak period is between 2000 to 2300 Pacific Time and is associated with the generation of the extended forecast fields.

A user fee is charged to the commercial users only. This fee reflects the actual cost of production of the various fields and the associated communication costs. For the international TYMNET users, an additional fee is charged. In Canada, this is called the Data-pak fee. Currently, the commercial user fee is $13.26 per connect hour to the PDP 11/60. All commercial users also must sign a NODDS User



Average NODDS Use, Two Peak Periods are Identified.

Figure D

Agreement which outlines the duties and responsibilities of the government and of the user.

In March 1984, a test of the ability of the INMARSAT communication satellite to relay a NODDS graphic product was successful. The test using the COMSAT Inc. facilities went from Monterey, CA to COMSAT Headquarters in Washington, D.C. With this success, any COMSAT equipped vessel will be able to access the PDP 11/60. This new capability could cause an almost instant expansion and management problem (i.e., fee collection) to the NODDS program.

III. THE PROBLEM

NODDS has expanded from its initial 1978 commercial user group to the current three user groups; DOD, other government, and commercial. The total number of users has more than tripled since the initial twelve users. However, the hardware has not kept pace with this increasing demand. To complicate matters, the system has become a jointly managed program between the Fleet Numerical Oceanography Center and the National Ocean Service (NOS) of NOAA.

Currently thirty-eight users access the system via five TYMNET ports and three users have hardwire connections. As the demand for FNOC products and data increases, the communications bottleneck becomes more apparent. The capability of the multiprogramming software of the PDP 11/60 is limited and can be saturated with the addition of additional ports. As each user group grows in number, a DOD versus non-DOD access priority will eventually become a management problem. A significant increase can be expected within the DOD user group with the availability of the Zenith microcomputers via the Navy/Air Force Master Contract. Also, the availability of at least two emmulators for this microcomputer to plot the NODDS graphics are currently available.

As the total number of users increases, the limited memory space on a mass storage unit decreases as new products and

data are added. The future access and memory space are the two most important aspects of the present NODDS system which require an immediate upgrade.

During the past three years the system has suffered from the first rule of networking, the lack of vision. A best fit solution is required which will satisfy both DOD and non-DOD users alike. Besides adding new users, recent requests for new data, especially marine and satellite, will saturate the mass storage unit.

IV. THE SEASAT DATA DISTRIBUTION SYSTEM (SDDS)

A. PRIOR TO SDDS

At least two commercial companies have made requests to the Fleet Numerical Oceanography Center for data prior to the SEASAT program. In July 1977, Environmental Resource and Technology, Inc. (ERT) of Concord, MA sent a letter to FNOC requesting data from the Spectral Ocean Wave Model (SOWM). This was in response to ERT's expansion of services in the Gulf of Mexico to numerous oil rig operations. A favorable response from FNOC came in November 1977. On April 20, 1978 a "Special Agreement" was signed between ERT, FNOC, and the Regional Counsel, Naval Supply Center, Oakland, CA. Termination of the commitment was on 30 Sep 1978. The initial costs were $38.50 per field per month, with an adjustment value for non-delivery of the field of $0.64 per 12-hour watch. The Spectral grid point data was $1.20 per point per month, with an adjustment value for nondelivery of $0.02 per point per 12-hour watch. All the billing was done in advance and the approximate total was $1,500 per quarter (three months).

A second commercial user also requested Navy data, again the SOWM model output, in May 1977. Ocean Data Systems, Inc. (ODSI) made this request, with the approval of NOAA, in order to provide additional commercial meteorological and oceanographic services to its customers. Obviously, for the eastern

Pacific region, this marine service company had the opinion that the NOAA marine data base was insufficient. A letter for initial request was sent in late May 1977, and the data became available in February 1978.

Now the access problem to unclassified DOD products was solved, even before the NASA SDDS Program began. The commercial users' requirements for wave and sea state information was not being provided for by the agency of the federal government that had the responsibility for dissemination and the Navy had the only "reliable" ocean wave model. With the implementation of the SDDS program an immediate user demand from the marine community, both government and commercial, could have been anticipated.

B. THE NASA SDDS PROGRAM

The SEASAT program was a component of a Commercial Demonstration Program of NASA that was divided into two parts. First, SEASAT data was to be delivered to the Navy, NOAA, and the Jet Propulsion Laboratory on magnetic tape for user site-specific processing. However, this unfortunately lasted only for four months between the launch date of June 1978 until the satellite failed in October.

With the early failure, a plan was devised to substitute FNOC products and data for the missing SEASAT data. First, a Master Experiment List of User Fields and locations was required. Second, a field availability list from FNOC was

compiled. This activity occupied most of the period between late 1978 to May of 1979. ODSI personnel were the prime investigators of this effort.

While numerous liaison and correspondence activity took place between FNOC, NASA/JPL, and the commercial users, a contract was let to Telos, Inc. for the software to acquire the fields from the FNOC mainframe and transfer them to a CDC 6500 computer and eventually to the SDDS host PDP 11/60 computer. This contract was partially completed in May 1979 (to the CDC 6500) and tested on 1 June 1979. A transfer of the required fields to the host PDP 11/60 computer was completed on 14 June 1979. The first operational bulletin on the SDDS system occurred on 25 June 1979.

For the next seven months, SDDS problems centered around:

1. Programs that were missing
2. Fields that were missing
3. Access problems by the commercial users
4. Navy backgrounds versus commercial background requirements
5. The priority of the NOAA radio station WWD for access
6. The problems with two users logged into the PDP 11/60 at the same time
7. Duplicate fields being produced

During this time, FNOC placed a limit of one hour CPU time on the CDC 6500 for providing the fields to the PDP 11/60. With the initial fields, this was fifty percent more than what was required. This time limit was imposed due to

the conflict for use of the computer (CDC 6500) with the Optimum Path Aircraft Routing System (OPARS). The users during this initial period were [Ref. 1]:

National Marine Fisheries Service, NOAA

Continental Oil Company

Vega Weather Services, Inc.

Ocean Data Systems, Inc.

ESSO, Canada

Atmospheric Environmental Service, Inc.

OceanRoutes, Inc.

U. S. Coast Guard, New York, NY

Getty Oil Co.

SDDS Resident Manager

SDDS System Analyst

Jet Propulsion Laboratory

This substitute phase included the storing and accessing by users of the various oceanographic and meteorological products that are generated from the FNOC models. Table 3 indicates these products. With the early failure of the satellite, a marked transformation of objectives took place at FNOC. The change in emphasis from the near real-time delivery of satellite data to the delivery of unclassified FNOC products put an additional burden on FNOC to satisfy non-DOD users. This is actually a NOAA mission.

For a program to continue for an extended period, a user group must exist that requires the data and/or the products.

Table 3

PRODUCTS	Levels	Time Periods	Format
Marine Winds, Direction	Sea Level	00,12,24,36,48,60,72	G , T, B
Marine Winds, Speed	Sea Level	00,12,24,36,48,60,72	G , T, B
Sea Surface Temperature	----	00	G , T, B
Atmospheric Pressure	Sea Level, 850 mb 700, 500, 300, 200 mbs	00,12,24,36,48,60,72	G , T, B
Significant Wave Height	---	00,12,24,36,48,60,72	G , T, B
Primary Wave Direction	---	00,12,24,36,48,60,72	G , T, B
Primary Wave Period	---	00,12,24,36,48,60,72	G , T, B
Spectral Wave Data	---	00,12,24,36,48,60,72	T
Environmental Observations	---	00	G , T, B
Pattern Separations	1,000, 500 mb	00, 48	G , T, B

G). Standard Tektronix Format T). Alpha/numeric Format B). Pseudo-Binary Format

FNOC Products Currently available on NODDS

In the case of NASA, during the late 1970's NASA was faced with various budget cuts. This Commercial Demonstration Program was a means to create a demand for the agency. It is questionable as to whether the initial users desired access to the SEASAT Data, or just access to the unclassified FNOC data base. A summary of the initial users is required to hint at this answer.

The Users can be separated into three essential groups: the Marine Fishing Industry, the environmental forecasting industry, and the offshore oil and gas industry.

C. THE MARINE FISHING INDUSTRY

Until SDDS, most of the fishermen from California to Alaska had little experience receiving weather information from facsimile recorders while at sea. Most of the information was received by radio from the National Weather Service, NOAA and/or the U. S. Coast Guard. The information received was essentially too general for fishing operations, especially if the fishermen were only licensed to catch a specific species of fish and that type of fish preferred certain oceanic thermal conditions. The SDDS program was a major improvement in determining prior to departure and while "at sea" where these oceanic thermal features were located.

D. THE ENVIRONMENTAL FORECASTING INDUSTRY

None of these users were receiving any graphic information that was available from the SDDS program during the initial

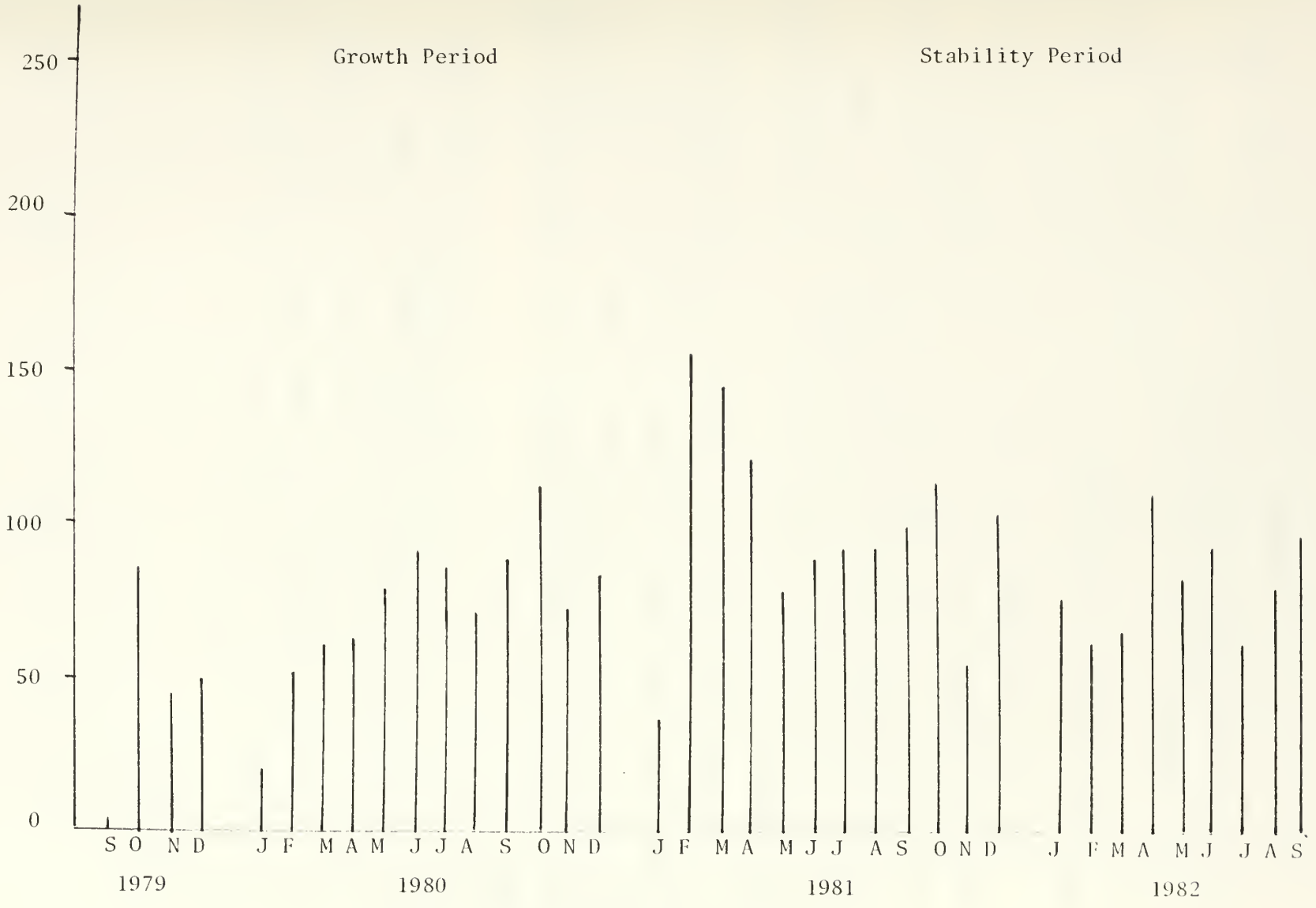
four months and remained on the system during the product transition period. Even one Canadian user remained on the list. Generally, the user's goal was to access the SDDS data in order to obtain observations and analysis/forecast charts over a broad area when other sources of information was very sparce. Also they wanted the objective analysis of the Navy model using a much more improved FNOC marine data base rather than the marine data base of the National Weather Service. A basic premise was to collect all available data and forecast charts.

E. THE OFFSHORE OIL AND GAS INDUSTRY

These users had two basic requirements: one, to acquire a historical archive of data for use in planning explorations and drilling operations, and two, to obtain real-time data on current oceanic and atmospheric conditions for warning current oil rig operations. In the past, some of these oil companies had used private weather forecasting companies for this purpose and also subscribed to numerous services of NOAA. The opportunity for accessing a Navy marine data base could not be passed up.

F. OVERVIEW

From September 1979 to September 1982, the SDDS program began with a growth period that lasted until early 1981. Figure E1 depicts a rise in the Resident Managers connect hours from an average of below 50 connect hours per month to



SDDS Resident Manager Connect Hours

Figure E1

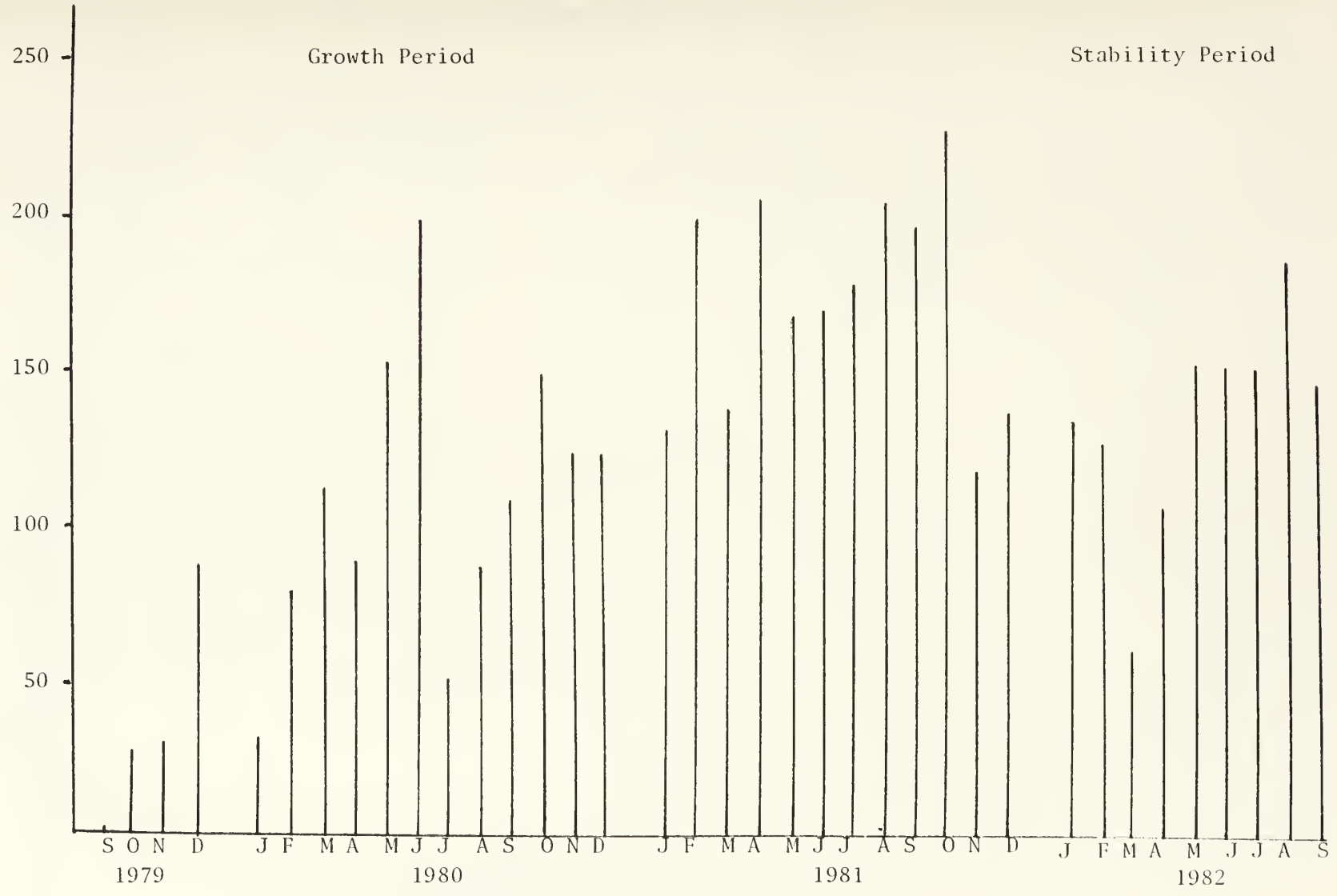
over 100 hours in April 1981. Following April 1981, a relatively stable period followed allowing for additional users and various operational problems to be solved.

The commercial users (Figure E2) had a corresponding similar growth period; however, it lasted till October 1981. Again, followed by a relatively stable period afterwards.

The other government users were rather slow in knowing about or accepting the system, since their growth period didn't begin till early 1981 (Figure E3). It is interesting to note that during the SDDS period, their use is almost cyclical with a peak during mid-year and a null period during the winter.

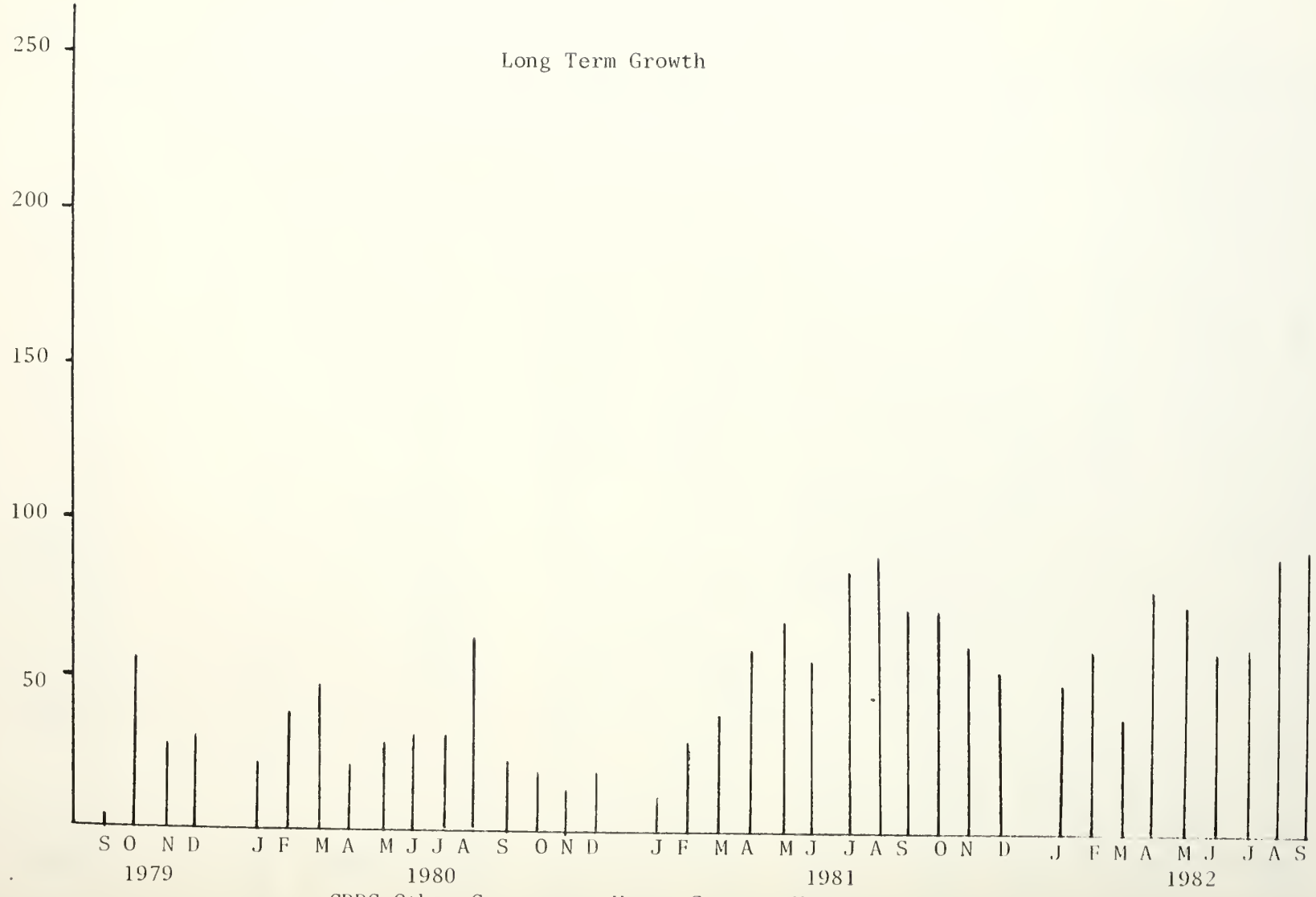
The DOD users (Figure E4) didn't even begin using the system until early 1981. FNOC was the first to test and evaluate the system from May 1981 to March 1982. Following this evaluation, a marked increase is seen beginning in April 1982.

Essentially, each of these user groups has a different view of SDDS access standards. The commercial group is willing to pay a user fee and essentially to log on and get off. The other government users seem slow to accept the system, and the DOD users who will wait for a test and evaluation period.



SDDS COMMERCIAL Users Connect Hours

Figure E2



SDDS Other Government Users Connect Hours
Figure E3

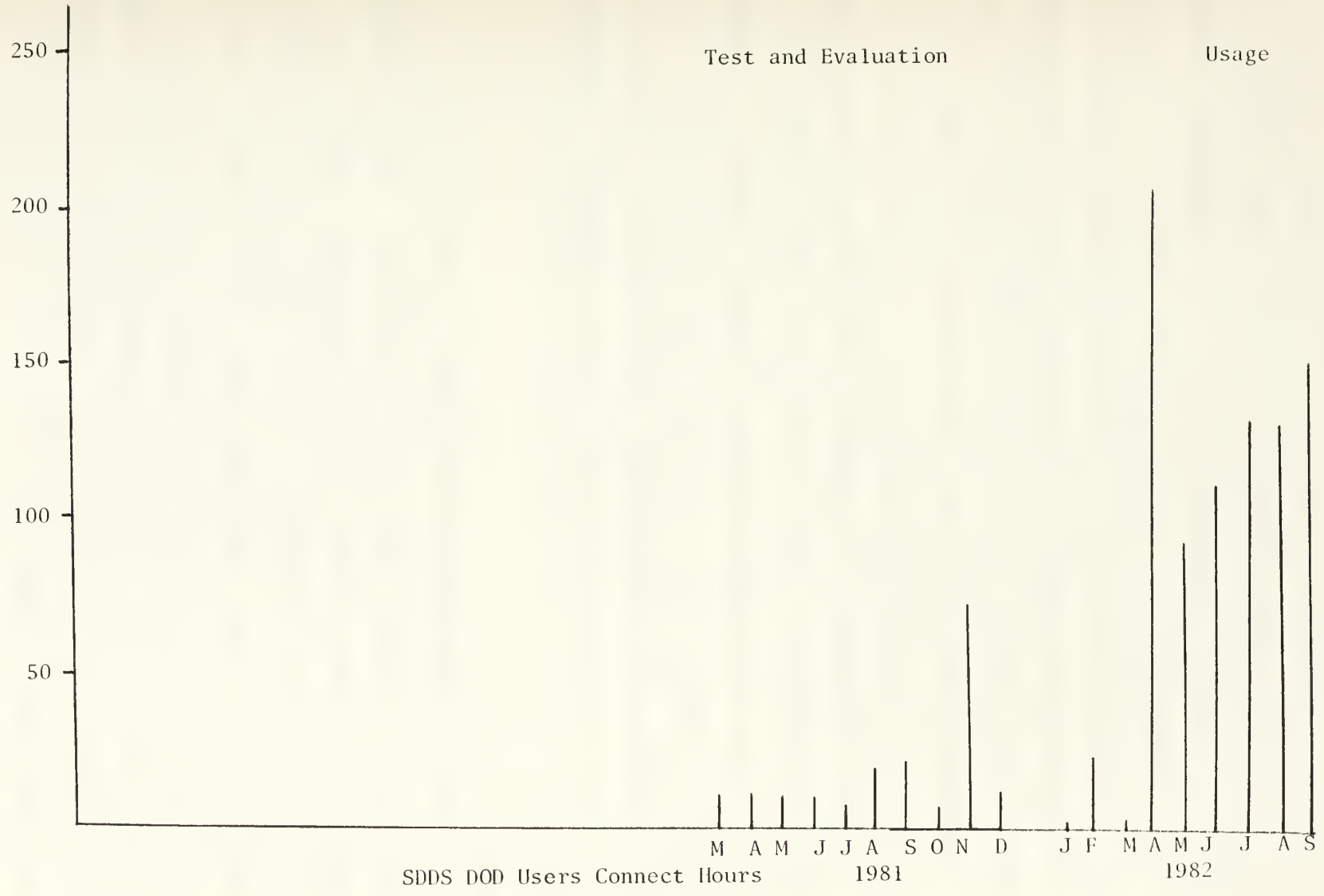

Test and Evaluation
Usage
250
200
150
100
50
M A M J J A S O N D J F M A M J J A S
1981
1982
SDDS DOD Users Connect Hours

Figure E4

G. 1979

In 1979 two basic steps were decided: first, that a master list would be determined as to what fields are needed by the users and at what locations; and secondly, to identify the unclassified computer jobs that produce these fields. One basic question concerned the use of the CDC 6500 computer; what was the relative priority of the SDDS program versus the Optimum Path Aircraft Routing System (OPARS) that also shared this CDC 6500 CPU time?

In May and June 1979, numerous SDDS jobs were tested and most of the products were late due to a low priority level on the normal FNOC computer run. However, on June 25, 1979 the first SDDS bulletin was issued. During the end of June through July, the SDDS managers were tracking file generation jobs and troubleshooting various Telenet problems. Numerous complaints came in from WWD, the National Marine Fisheries radio station.

In August and September, numerous computer jobs remained late and/or crashed, resulting in no product. Also, unknown changes in the Telos, Inc. programs were made without the knowledge of the SDDS manager. Also, FNOC programmers were changing some of the field generation jobs to conform with other DOD requests. These FNOC changes were also unknown to the SDDS Manager. The constant problem that always arose was what did the users want, versus what the Navy changing background fields were.

During November and December 1979, Telenet problems increased and WWD was unable to log into the system for three days. Also during this period, the conflict with the OPARS program for CDC 6500 CPU time became crucial and the SDDS program was limited to one hour of CPU time per day for the generation of commercial products. Another problem that required attention was the fact that two users of the SDDS host computer could not remain logged on at the same time. This problem gained in frequency among the uses in a very short period. To add to the confusion, the users were calling the FNOC computer operations center instead of the SDDS Manager to report various problems. Needless to say, this put a strain on the relations between the commercial users and the Navy, which by their own mission, they were not supposed to support.

H. 1980

During 1980, most of the problems were centered around communications, hardware, and the basic operational procedures of the system. Again, as in 1979, various products were not produced due to a Navy priority scheduling problem and/or not running program "UZPDP" which transfers the generated fields from the HAL CDC 6500 computer with the application of various backgrounds, and forwarding to the PDP 11/60. Also, between February 6, 1980 to March 26, the SDDS Resident Manager was on sick leave and little progress was made during this period.

The communication problems centered around various areas. The user product receipt times were not coordinated with the product generation times, users wanted to upgrade their transmission baud rates to 1200 or 1600 baud. Users continued to call into the Navy computer operations center (FNOC) about SDDS problems, rather than the SDDS Resident Manager's office. Also, two local users questioned the quality of the transmission lines from the PDP 11/60.

The SDDS Manager must coordinate user directory changes at least three days in advance and this often is not satisfactory to the user needs. Another aspect the SDDS system had to contend with was the fact that other FNOC programmers were not notifying the SDDS managers that changes were made that affect the generation of some of the SDDS products. To make matters worse, Telos Inc. closed the local office on 30 June 1980 and another "UZPDP" programming expert was not available.

The SDDS system was criticized for not being able to support a full time dedicated user and not being able to support six to nine users in a multiprogramming fashion. This led ODSI on 20 May to prefer to use the direct connect to HAL rather than the front end PDP 11/60 communications port. However, an unsuccessful 9600 baud access test to HAL in late May proved to ODSI that the slower PDP 11/60 port was better.

Finally, in June, 1980 a user meeting was held. An Operational Manual was introduced which had been worked on since January 1980. Users requested a large product memory capability for archiving purposes, yet adding additional memory was whose responsibility, Navy or NASA? The PDP was a NASA machine in a joint Navy/JPL project. This additional memory was an additional request, not included within the original SDDS concept.

In July 1980, the Telenet problems became too great and JPL requested FNOC to change to TYMNET. A radio paging system was also requested for the SDDS Manager. In August, the first university request for SDDS access occurred from University of California at Davis.

During September, most operational problems (late products) persisted and a product labeling problem arose. Products were labeled according to the production date and not the verification time of the chart. Also, besides the constraint of using the HAL computer for one hour of CPU time, other various Research and Development jobs were raised to a higher priority. This further delayed the receipt of SDDS products.

User requests also were received for the southern hemisphere, so a second conference occurred on September 24-26. On September 29, Nimbus satellite data was made available via the SDDS system. However, Telenet problems persisted.

During October, various user passwords and ID codes were deleted due to a head crash. These fields were restored in

one day; however, access was denied to several users. Also, FNOC implemented a Computer Resource Accounting System (CRAS) which was not coordinated with the SDDS program.

On November 14, 1980, WSFO Redwood City, CA used the Marine Fisheries Services ID code for a demonstration. During most of the period, products and data still remained late in terms of the users deadlines.

I. 1981

Both communication and administration problems continued throughout 1981. Many conditions were continuously being worked on or monitored. The requirement for a 4800 bps line between the host computer and the computer at ODSI in Monterey, and the computer at Ocean Routes, in Palo Alto, was eventually successful on 26 January 1981. However, both users could not access the computer at the same time.

Besides this 4800 bps communication line, other communication problems concerned Telenet both in southern California and Alaska. Users also continued to call the Navy Operations center for SDDS products that were late or not produced. The continued Telenet problems resulted in a decision to test Tymnet in November 1981, and a change based on competitive bids, from Telenet to Tymnet occurred on 1 January 1982.

The users during 1980 and 1981 continued to call the Navy for lack of products instead of the SDDS Manager. This led to the hiring of an assistant manager in January 1981. This

need was evident; however, as soon as the assistant manager appeared, the SDDS terminals required repair and the units had to be returned to JPL in Pasadena, CA. This repair period lasted two months, and during this time system monitoring, product updates, and solving user's problems were all seriously impaired.

By June 1981, most of the users started to change from tabular data to graphic, spectral or binary formats. This required major changes in user product directories. Often, the user product schedules did not match the product time at FNOC. Servicing the users while both the user environment and the computer operational environment at FNOC were changing finally led the SDDS Manager to leave and accept a position as a system analyst with FNOC. This left the new assistant manager in charge and after his initial training, his biggest problem was becoming familiar with the system products. Now, his training concentrated on meteorology and oceanography and especially on the terminology of these sciences.

J. 1982

Operations continued in 1982 under much the same conditions as the latter half of 1981. By mid-year, NASA/JPL expressed an intent to terminate its association with the SDDS program effective 1 October 1982. Essentially, the NASA demonstration goal was complete. Within a month, the recommendation was made to the National Weather Service of NOAA

to interface with the Navy for the management of the system. With the removal of JPL, the Navy would be operating a data distribution system for non-DOD users which is not inclusive within the FNOC mission.

In August 1982, the Commander, Naval Oceanography Command [Ref. 2] issued the following guidance for the SDDS program:

1. The SDDS shall be changed to the Navy Oceanographic Data Distribution System.
2. There shall be a fair share User Fee.
3. JPL will provide a manager of the NODDS, who will be the sole point of contact for the civilian agencies.
4. The civilian use of the NODDS shall be on a "not to interfere with" basis in relation to the normal computer operations at FNOC.

FNOC planned to operate the SDDS for six months in FY83. Meanwhile, NOAA planned to study the system during this period. The resident manager resigned effective 1 November 1982 and FNOC paid JPL approximately $50K in order to manage the system under contract for the six-month period. JPL in turn contracted with Science Applications, Inc. of Monterey, for the resident manager. Effective 1 January 1983, the user fee was calculated as $8.40 per connect hour.

V. THE NAVY OCEANOGRAPHIC DATA DISTRIBUTION SYSTEM

A. 1983

With the termination of the JPL/Navy agreement on 31 September 1982 concerning the SDDS program, the SDDS was renamed the Navy Oceanographic Data Distribution System (NODDS). JPL was paid by FNOC for continuing to manage the system for six months after 1 October 1982 in order for NOAA to evaluate the system. This daily management function was further subcontracted by JPL to Science Applications Incorporated (SAI) of Monterey, CA.

By January 1983, the NODDS system had two DOD users, three other government, and five commercial users. The expansion of the program now included the possible split in service between DOD and non-DOD. Essentially, FNOC would service the DOD community via the existing hardware at Monterey, and NOAA would implement a similar system originating from the National Meteorological Center located in Washington, D.C. For each agency to have a common field data base, an error free transmission between the two centers, via a data link, was required. For this purpose, a NOAA Corps Liaison Officer was sent to FNOC in May 1983.

An FNOC/NMC data link line had been in existence for some time; however, a successful set of data and field transmissions

was never achieved. One of the first priorities of the NOAA liaison was to attain this successful field/data exchange.

In March 1983, the NODDS User Fee increased to $9.90 per connect hour to the host PDP 11/60 computer. On 1 July, NOAA began collecting the User Fees for NODDS, since this was clearly not an FNOC mission; i.e., to serve the non-DOD community. NOAA transferred $13K to FNOC for SAI contract payment for the period through 30 September 1983.

Several points of concern were expressed by SAI to JPL [Ref. 3]. They were:

1. A major limitation to the growth of the NODDS system is the front-end machine, presently a PDP 11/60. The PDP 11/60 is not a large nor fast computer, and central memory is an important consideration. The machine is starting to show signs of strain with the present number of users.

2. As data becomes available, users access the NODDS and invoke OS tasks (which require central memory) to receive the data. The transfer of data from HAL (CDC 6500) to the PDP also requires central memory. As a result, when all nine ports are busy, the operating system is under a great deal of strain. All nine users can receive data with no reduction in service but the operating system's response comes almost to a standstill.

3. The ability to access the PDP is another consideration. There are only five TYMNET ports. In my opinion, even if the FNOC-TYMNET System could support more lines, the PDP operating system could begin to whine under the strain. One FNOC technician feels that the system could not accommodate 4800 bps users simultaneously, even though there are ports available.

4. The 200 UT protocol is rather unsophisticated and cannot handle large data transfers at high rates. An upgrade to the protocol has been suggested before.

5. In terms of disk space, NODDS uses approximately 43% of the disk space presently available and so it is

not an immediate problem. However, there is only one disk (RP 05), which holds the operating system, products and directories.

6. The hardware configuration of the front-end machine requires the most attention in regards to the expansion of the NODDS system. Determining problems with the present configuration and how to best upgrade the system requires careful consideration.

7. In addition, questions such as whether or not one resident manager can adequately handel the needs of the users must be addressed. Factors such as the numbers of offtime (late night and weekend) calls as well as the response time required to accommodate user's requests for changes in products should be considered.

8. FNOC is going to have to re-examine the size of NODDS, the services it is providing, and the impact NODDS has on FNOC's operations. Specifically, NODDS is limited to one hour CP time per 12-hour watch on the PEPS and HAL computers for non-Navy users. We should determine what is to be done if this time is exceeded.

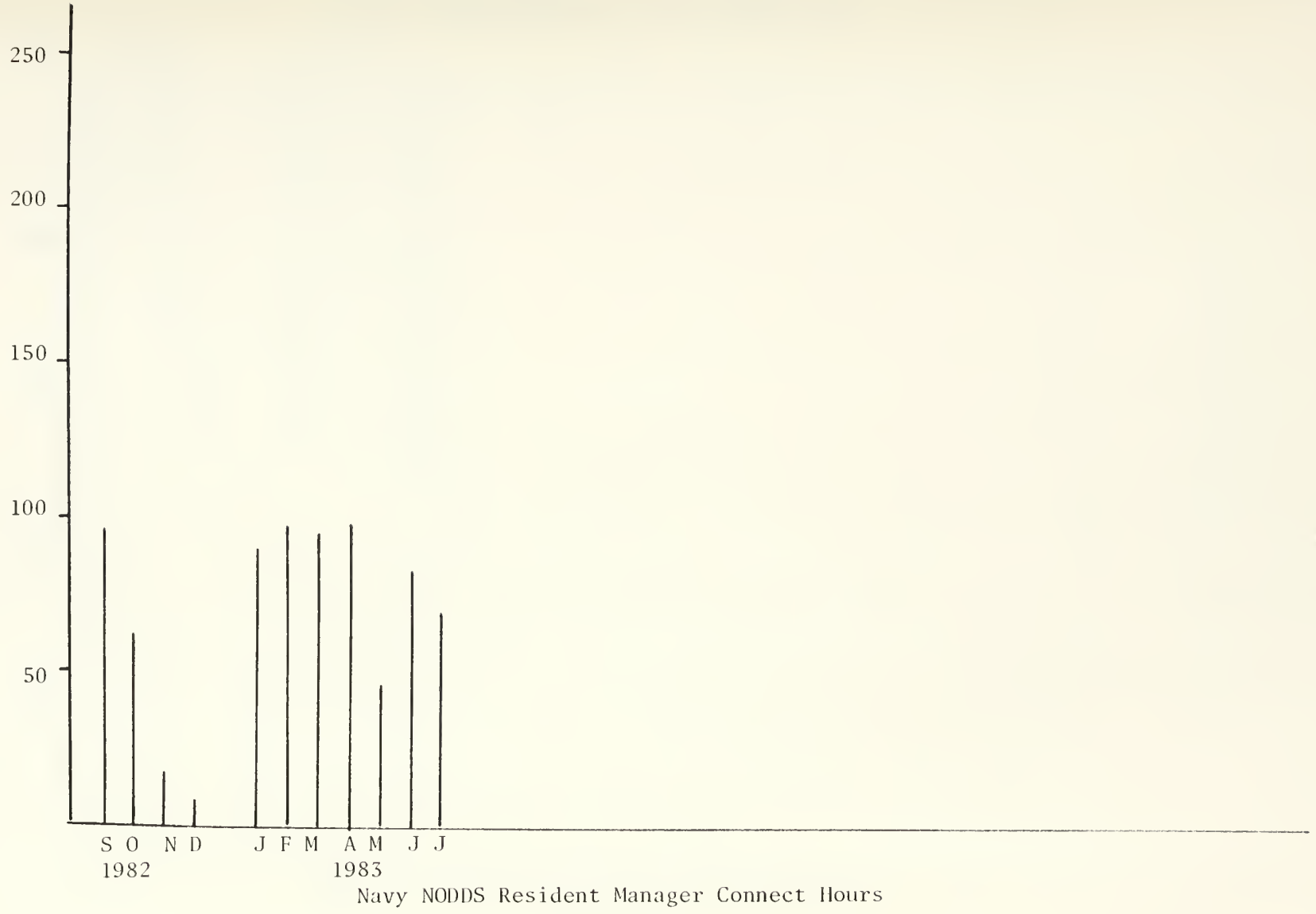
9. The priority of the NODDS jobs should be reconsidered because, as it stands now, if FNOC moves to a shortened runlist because of problems with the watch, NODDS jobs are cut. This may not be acceptable, if NODDS continues to grow at its present rate.

B. OVERVIEW

The Navy Oceanographic Data Distribution System was very short in duration; however, some significant user patterns developed. The Resident Managers continued its normal connect pattern of 50 to 100 hours (Figure F1) and the user community added few new users.

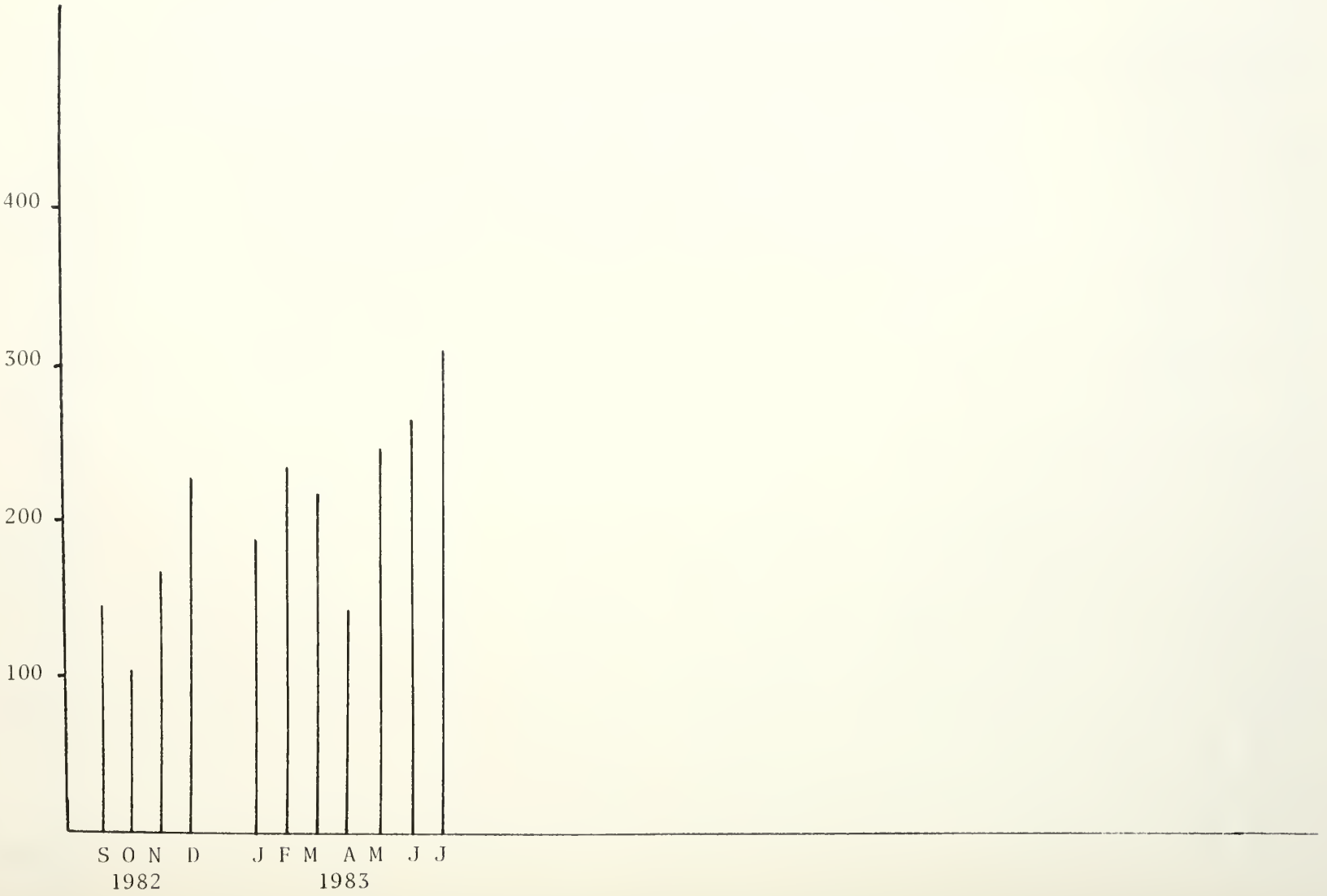
The commercial users, however, began another growth period exceeding 300 connect hours by July of 1983 (Figure F2). The other government users continued on their cyclic path.

However, their long term usage had nearly doubled since 1979 (Figure F3). The DOD users continued their growth pattern (Figure F4); however, the commercial users were the group with the most connect hours.



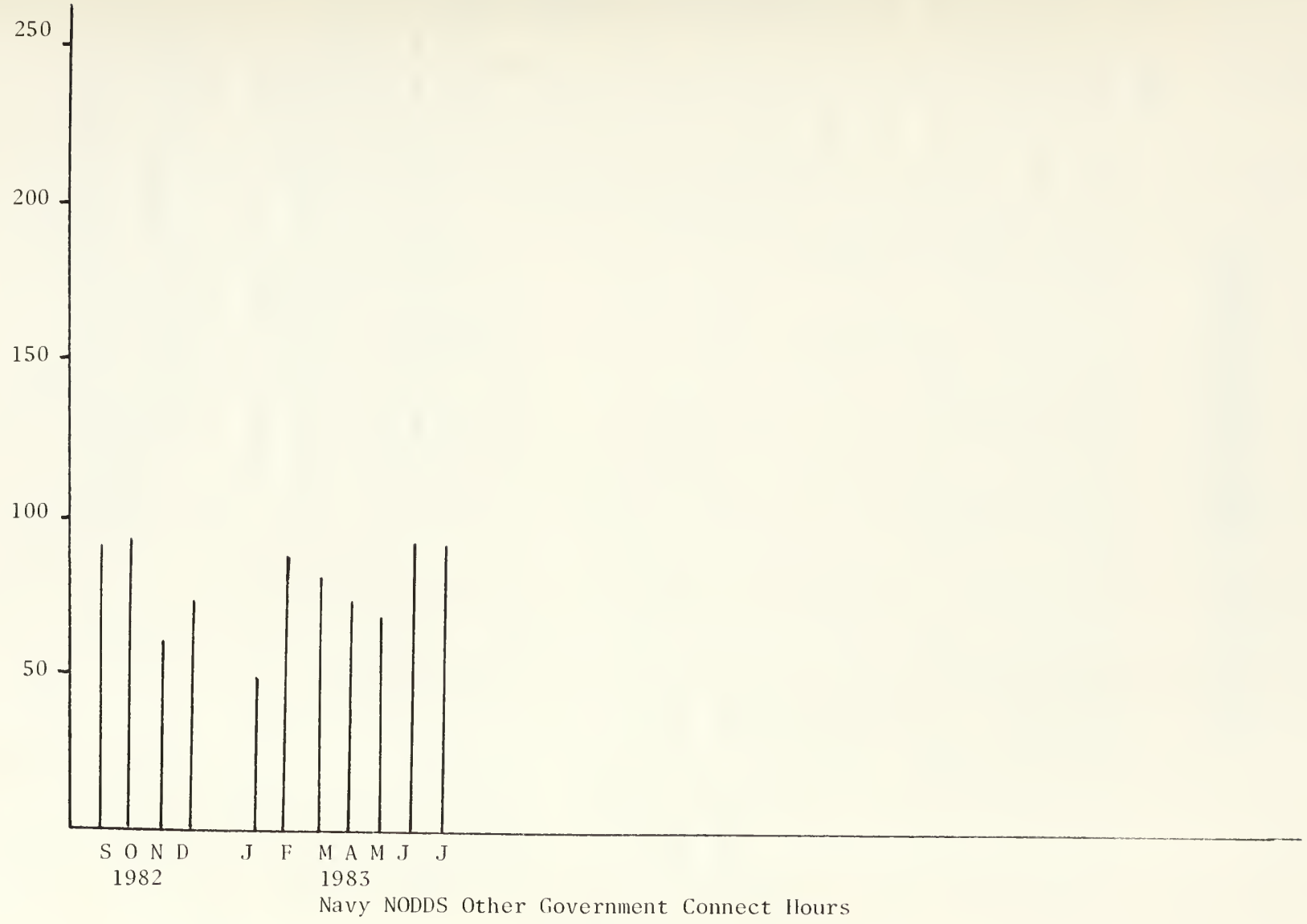
Navy NODDS Resident Manager Connect Hours

Figure F1



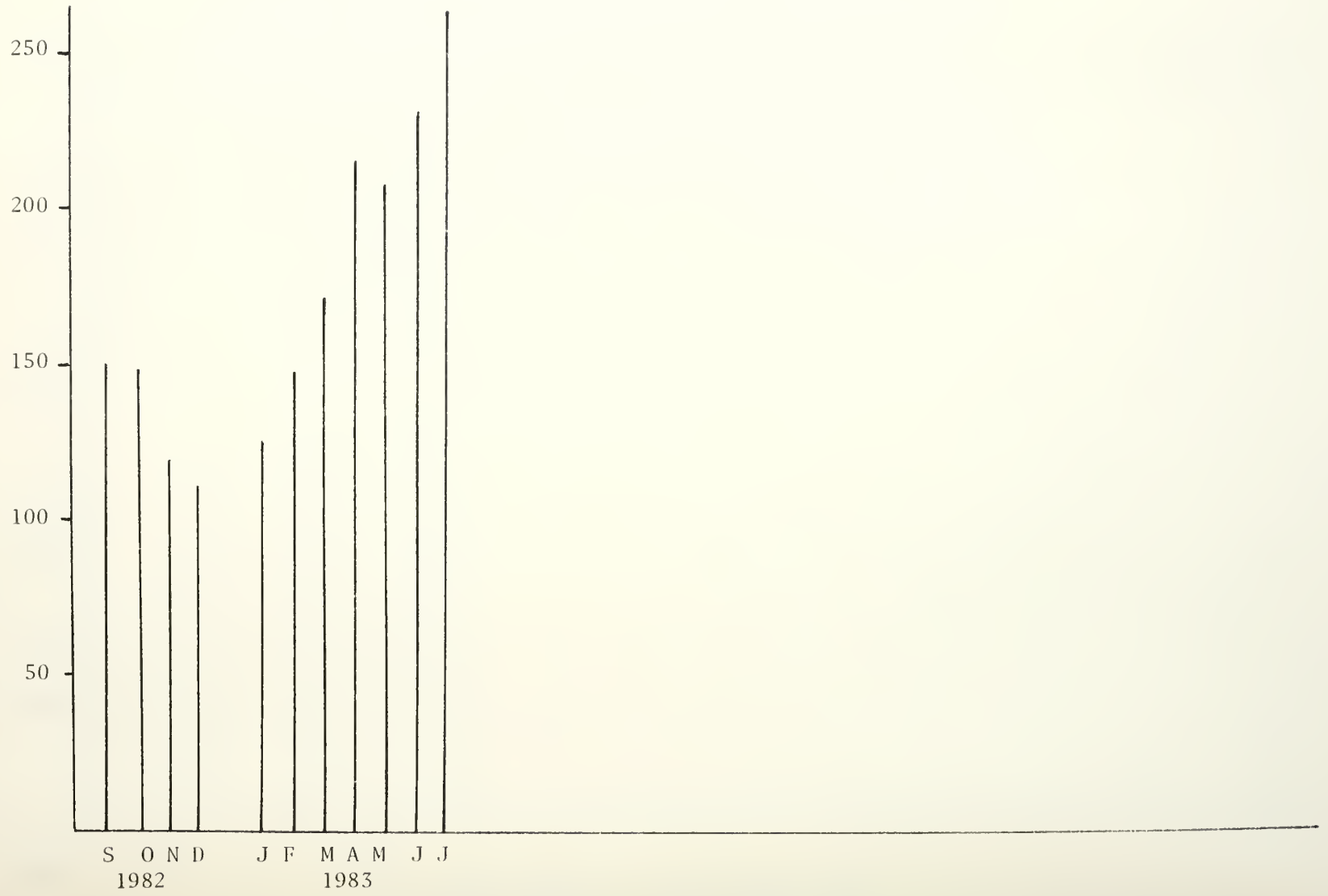
Navy NODDS Commercial User Connect Hours

Figure F2



Navy NODDS Other Government Connect Hours

Figure F3



Navy NODDS DOD User Connect Hours

Figure F4

VI. THE NAVY/NOAA OCEANOGRAPHIC DATA DISTRIBUTION SYSTEM

A. 1984

Joint Navy and NOAA funding began in July 1983; however, an official Navy/NOAA Oceanographic Data Distribution System (NODDS) was not agreed to until September 1983. During late 1983 and into 1984, the NODDS problems could be classified into either the operation or communication realms. Products during January 1984 remained late, requiring various DOD requested products to be rerun on the FNOC mainframes. Also, numerous transfer problems occurred via the UZPDP software from the CDC 6500. At one point, the FNOC computer watch officer was not aware of the missing fields for a three to four day period.

The first week of February saw the effects on product availability to the NODDS system when two FNOC mainframe computers went down. FNOC went into a reduced product mode and NODDS products were either "not available" or "late." Also, the relative priority of the NODDS was questioned when the plans for the PEPS replacement computer program was announced. The NODDS priority levels of 2 to 4, out of a high of seven, required being increased to a five in order to avoid being truncated from the computer run.

Communication problems were evident during March and April, with the Alaska TYMNET and various NIMBUS satellite data arriving late. No progress was evident with the UZPDP program hangs.

In May, the first saturated access problem arose. Both Western Fishboat Owners Association and the U.S. Coast Guard reported that "no ports" were available when they desired access. Some communication problems also extended into Canada.

The major problems during July concerned the changes in the background grids used by the NODDS, yet deleted by DOD units due to non-use. Absolutely no coordination between the non-DOD user and the FNOC programmers was done.

Normal operations continued into August and September. On 1 October, 1984, the NIMBUS 7 satellite data stopped arriving at FNOC due to the lack of funding by NASA for the preprocessing of the data at their Alaska Tracking station. During this period some TYMNET problems continued in the San Diego and Salinas TYMNET nodes.

A new resident manager's terminal, a 4695 Tektronix color copier and a 4105 color terminal were installed on November 1. TYMNET also established an Alaska TYMNET trouble phone number. Again, NODDS was also asked by a major commercial user to have an archive capability.

In December, new user terminal operators were hired by various users and the NODDS resident managers were inundated

with terminal questions during non-normal working hours. Also, an inactive account policy was implemented. The need for a NODDS product catalog was also recognized.

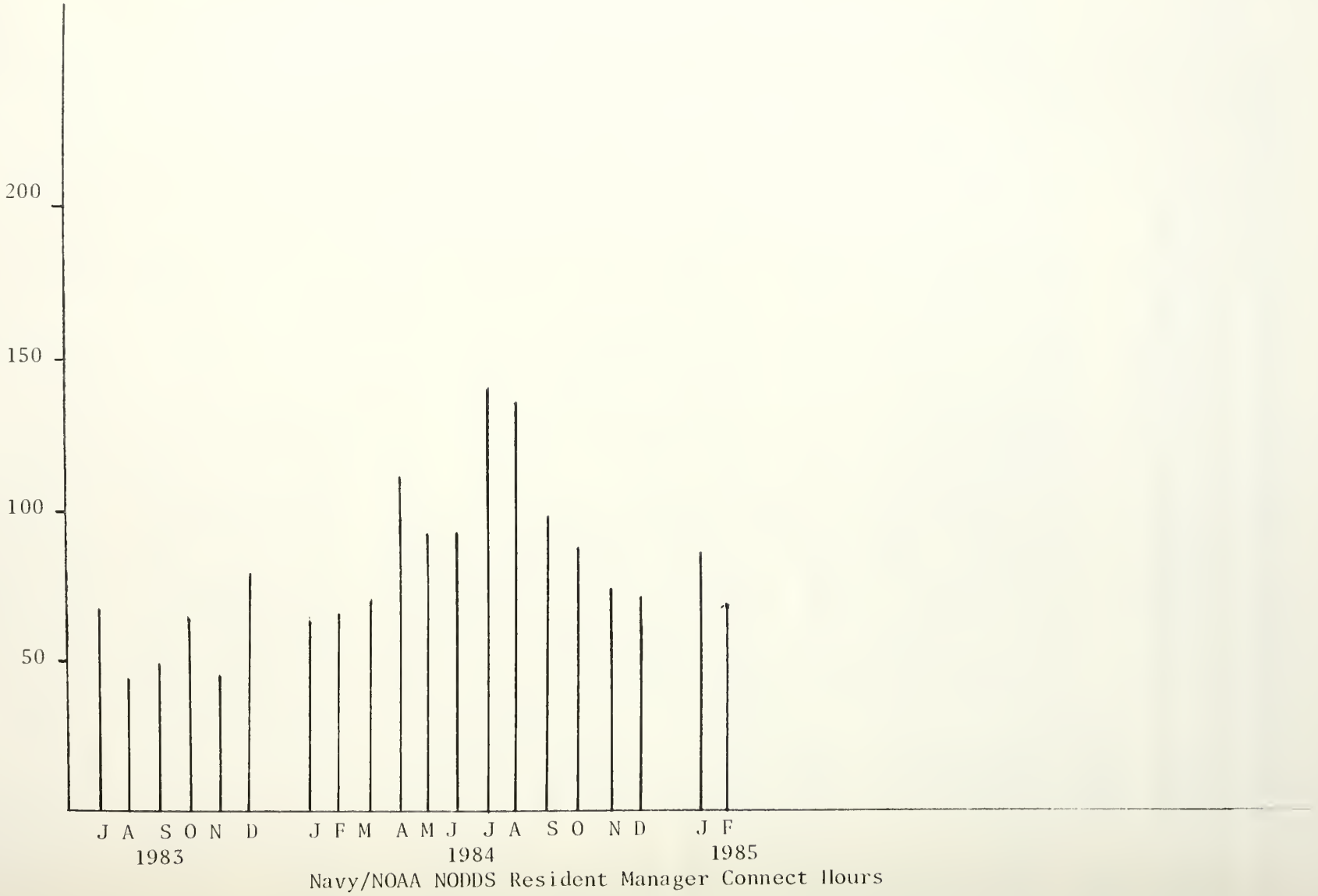
B. OVERVIEW

From July 1983 to the present, the Navy/NOAA Oceanographic Data Distribution System continued to expand both in products and in number of users. The resident managers total connect hours reflected this usage by nearing or exceeding the 100 connect hour mark for six months (April-September 1984). (Figure G1)

The commercial users maintained their growth pattern, reaching a peak of 412 connect hours in March 1984. Since 1980, these commercial users have nearly tripled their connect hours to the system. However in October 1984, the loss of the NIMBUS satellite data resulted in a significant loss and the usage declined to nearly half of the earlier year's monthly total. (Figure G2)

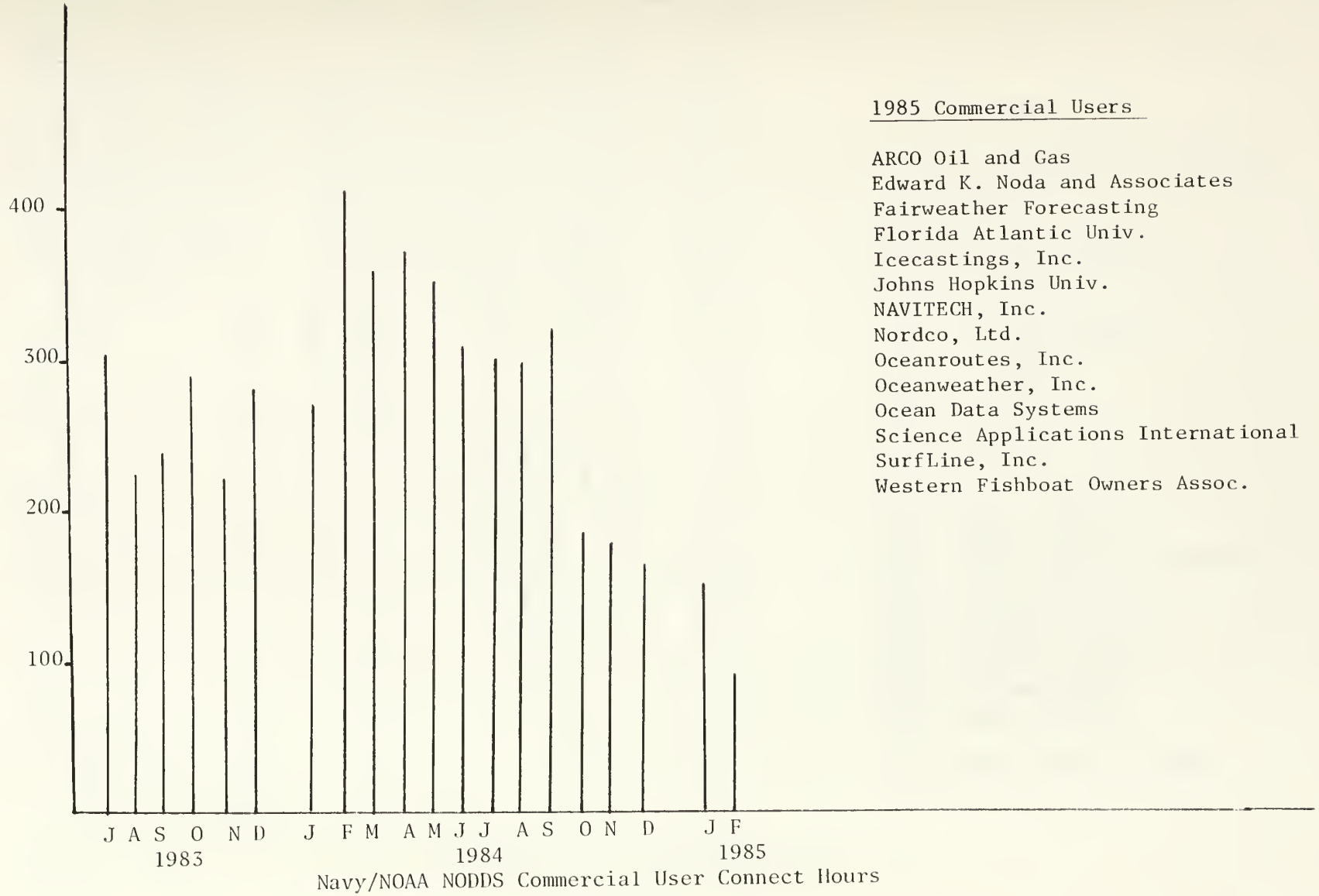
The "other government" user group began a growth pattern in mid-1983 and it is still evident today. Today's usage is nearly double that of the 1982 rate. (Figure G3)

The DOD growth pattern of 1982-1983 continued with a peak in February 1984. Since this month, the decline has been steady due to the installation of a 15 minute TYMNET disconnect for non-use of the system. Previously, numerous DOD and other government users were abusing the system access by remaining on the system without any product retrieval activity.



Navy/NOAA NODDS Resident Manager Connect Hours

Figure G1

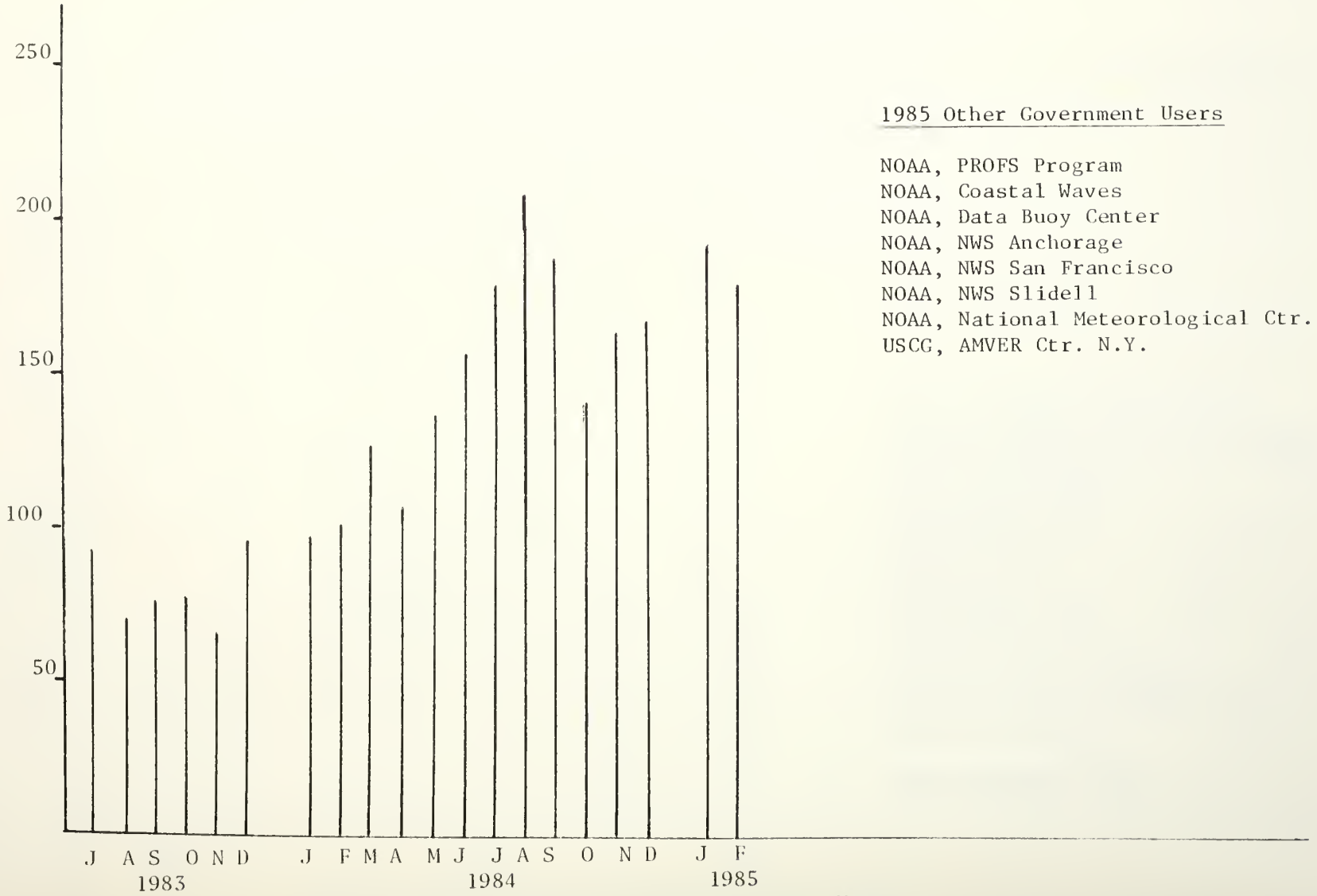


1985 Commercial Users

ARCO Oil and Gas
Edward K. Noda and Associates
Fairweather Forecasting
Florida Atlantic Univ.
Icecastings, Inc.
Johns Hopkins Univ.
NAVITECH, Inc.
Nordco, Ltd.
Oceanroutes, Inc.
Oceanweather, Inc.
Ocean Data Systems
Science Applications International
SurfLine, Inc.
Western Fishboat Owners Assoc.

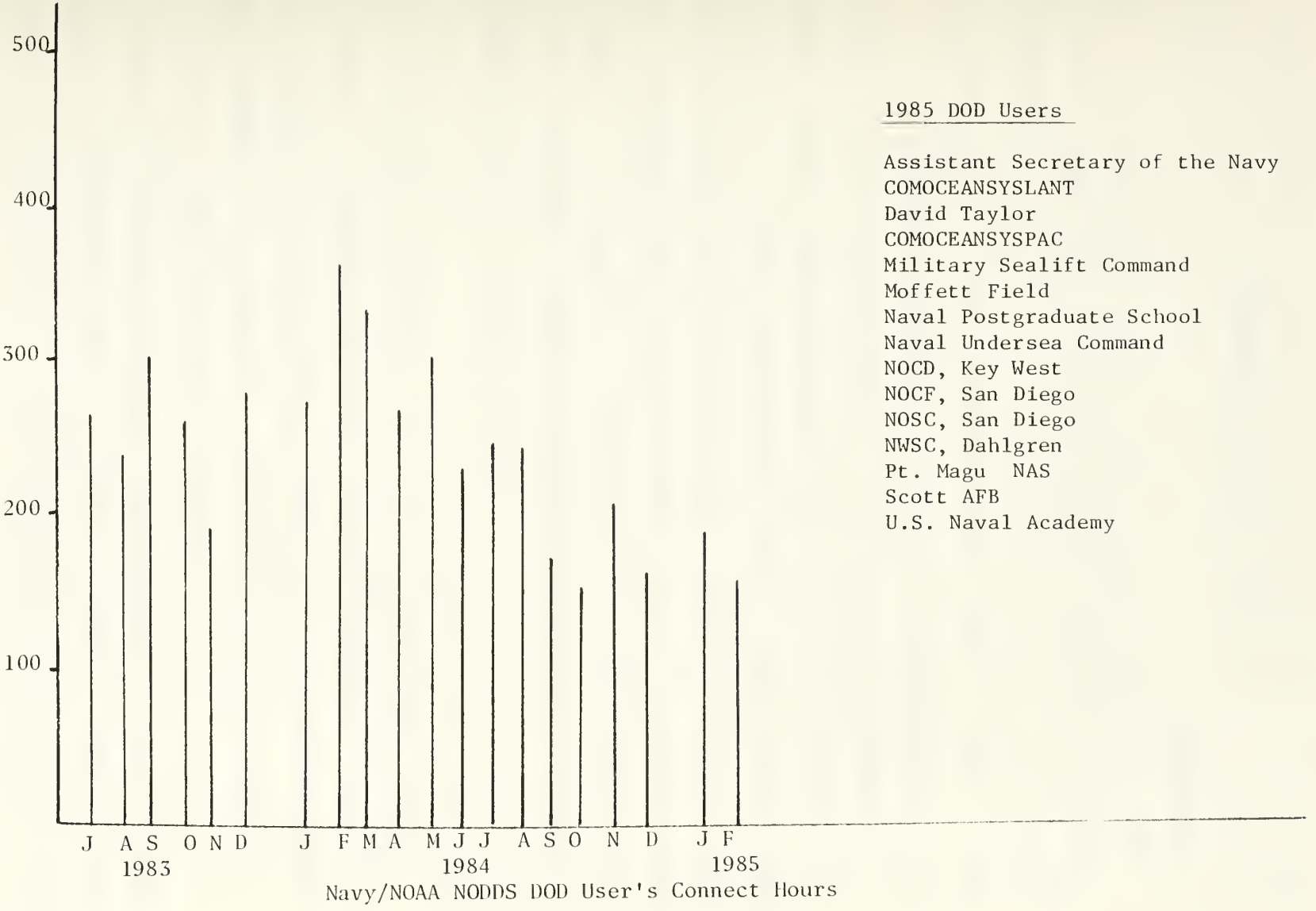
Navy/NOAA NODDS Commercial User Connect Hours

Figure G2



Navy/NOAA NODDS Other Government Connect Hours

Figure G3



Navy/NOAA NODDS DOD User's Connect Hours

Figure G4

VII. SYSTEM PROBLEMS

A. HARDWARE

Two recurrent problems have already been mentioned: the availability of memory space on the 128K CPU memory, the memory disk, and the user access bottleneck via the TYMNET ports. Both of these problems have become the main thrust for the replacement of the host PDP 11/60 computer.

The mass memory unit has only 88 mega-byte memory and it is estimated that 40-45 percent of this space remains available. Previously, in 1983, an archiving capability for various products was requested. However, this 88 mega-byte limitation would allow only a very selected portion of the products to be stored for over ninety-six hours. This limited storage also does not allow for any large amount of satellite data to be stored on it and only small amounts of FNOC processed data.

Seven TYMNET ports is not only a hardware limit, but also a limit of the PDP 11/60 operating system. A recent load test with all the communications ports busy proved successful for obtaining fields. However, the resident managers were not able to change or update any files. Adding additional ports would probably saturate the PDP 11/60 and result in an increase in "down time" for rebooting the computer.

A third consideration is for the age of the PDP 11 computer. It is now over fifteen years old and the amount of required maintenance has increased over the past year. Currently, two hours of preventive maintenance is performed per week. Table four indicates the various causes for non-access to the system.

B. SOFTWARE

Three major concerns are relevant to the software of the system: first, the variability of the user graphic requirements; second, the development of at least two Zenith system emulators allowing NODDS graphics to be displayed; and lastly, the low priority of non-DOD software support for NODDS within the responsibilities of FNOC. The first two concerns indicate the need for a larger host computer and communication interface. The third concern requires the addition of NOAA programmers to be colocated at FNOC.

The requirement for the various graphic requirements by both DOD and non-DOD users and still maintaining a global coverage, can only result in a standardization of graphic backgrounds. This may, or may not be, acceptable to the DOD community, who probably wishes to obtain the highest degree of resolution.

With the proliferation of Zenith terminals into various Navy and Air Force Commands, the requirement to train terminal operators and identify specific NODDS requirements is critical.

Table 4

NODDS DOWN TIME ANALYSIS

	PDP 11/60 Restarts	Delays In Opl Run	CDC 6500 (Hal) Plbms	TYMNET Plbms.
Jan, 84	2 (2 Hrs.)	-	-	1 (3 Hrs.)
Feb,	-	2 (3.5 Hrs)	3 (4 Hrs)	1 (3 Hrs)
Mar,	-	7 (15 Hrs)	1 (1 Hr)	-
Apr,	-	5 (12 Hrs)	5 (29 Hrs)	-
May,	-	4 (11 Hrs)	2 (10 Hrs)	1 (2 Hrs)
June,	-	3 (5 Hrs)	-	3 (3 Hrs)
July,	2 (.4 Hr)	2 (1 Hr)	2 (25 Hrs)	4 (4 Hrs)
Aug,	1 (2 Hrs)	4 (12 Hrs)	1 (1 Hr.)	1 (.5 Hr)
Sept,	2 (1 Hr)	4 (3 Hrs)	4 (3.5 Hrs)	2 (8 Hrs)
Oct,	1 (3 Hrs)	2 (1 Hr)	1 (1 Hr)	1 (.5 Hr)
Nov,	2 (2.5 Hrs)	1 (2 Hrs)	-	1 (2 Hrs)
Dec,	1 (.5 Hrs)	2 (3 Hrs)	-	1 (1 Hr)

NODDS Logged Problems for Products being Late, Incidents (Total Hrs.) per month.

Often, these requirements follow a short usage period, usually a few months. This will put an additional burden on the NODDS Resident Managers; an extra person will probably be required. The relative importance of mercator versus polar stereographic graphics will be another issue as the number of users grow.

These changing graphic requirements combined with the relatively low non-DOD reprogramming priority will lead to a somewhat unresponsive system. This is especially true for the current commercial user group. Additional NOAA and/or Navy support will be required if the user groups continue to expand and graphic standardization is to be avoided.

C. MANAGEMENT

Several topics concern the management of the NODDS program. The 1984 NODDS Memorandum of Agreement expired on December 31, 1984, and the system is essentially operating under the same guidelines by a mutual informal agreement. The new NODDS responsibilities for each agency are incorporated in an "umbrella" type agreement that is now in draft format. Both the 1984 and draft "umbrella" agreement are included in the appendix. For any long term co-management this or some other agreement will have to be finalized.

The user fee began at $8.80 per connect hour and has steadily increased to the current $13.26. This fee reflects the cost of producing the product, any technological support,

and product communication. However, this does not reflect the net worth of the product, which is significantly higher. The small commercial user fee perceived limit has been estimated at near the thirty dollar per hour rate. The problem is keeping the fee low enough so that the system accomplishes the NOAA objective of distributing the products to the commercial sector. The most recent user fee calculations are included in the appendix.

The resident manager contract has been filled using the JPL Master Contract with NOAA. However, in 1984, the Resident Manager requested additional hours for after hour work and resolving after hour telephone calls. As the number of NODDS users increase this amount of required support will increase and reflect itself in a high hourly user fee. Another aspect of providing this management is its low GS salary. Having a GS seven to nine resident manager would be very difficult in the high cost Monterey area. Trained Navy Resident Managers do not exist at the current time.

VIII. THE NAVY/NOAA RELATIONSHIP

A. GENERAL

Since July 1983, the NODDS program has been jointly administered. This has been essentially due to the different missions associated with the Navy and NOAA. The Navy's responsibility has been, since the original SDDS program, the generation and transfer of the unclassified products to the host PDP 11/60 computer. Since 1982, the Navy has also been responsible for the TYMNET communications costs. Meanwhile, NOAA has the responsibility for providing the daily management of the system. This can be accomplished by either using the current Science Applications International Corporation (SAIC) personnel or by future government employees. In accepting new NODDS users, FNOC approves all DOD requests and NOAA reviews all non-DOD requests.

The commercial users must sign a NODDS User Agreement with NOAA that remains in force for one calendar year ending 31 December 1985. The standard form of this agreement is included in the Appendix.

Essentially, the NOAA/Navy relationship remains by informal agreement based on the 1984 NODDS Memorandum of Agreement. However, both agencies have different objectives and concerns for the system as it now exists.

B. NAVY CONCERNS

The Navy must maintain whatever DOD requirements are imposed on the system. The long term effects of the Master Navy/Air Force Zenith terminal contract can only be assessed in the future. But even if a small portion of the CRT terminals are used for accessing the NODDS system, saturation of the existing communication system will occur. With at least two Tektronix emulators for accessing graphic products now available, the DOD user demand could increase significantly in a short period.

This DOD increase could result in a confrontation between DOD-access versus the legality of a NODDS User Agreement with a commercial user, operating in a communications or memory saturated state. In this case, the joint management of the system would break down, and Navy would have to revert back to a policy of DOD users only.

Of greater concern to the Navy is the growing TYMNET charges. Currently, the OPARS and the NODDS systems use this communication network. The total monthly charges for both programs varies between twelve to eighteen thousand dollars per month. The NODDS portion of this bill is about one third, ranging in size from three to five thousand per month. The commercial user portion of the NODDS TYMNET charges varies between one to three thousand. The commercial user fee represents their "fair share" of this cost, yet NOAA sets and collects this

fee with no Navy reimbursement for this service. Eventually, NOAA may have to transfer funds to the Navy for this commercial and possibly the "other government" use of the NODDS system. The Navy has kept the TYMNET system in part due to the commitments of the larger OPARS program. One of the options the Navy has is to replace the TYMNET communications with a DOD Data Defense Network (DDN). If this were implemented, the commercial users would have to provide the entire cost of the TYMNET communications ports or terminate service. If this be the case, the commercial user fee would soar past the cost effective point for the small commercial user. In essence, the system would revert back to a totally governmental user community.

C. NOAA CONCERNS

The NOAA mission includes the dissemination of environmental products and information to the public. In this effort, NOAA must serve the other non-DOD governmental agencies and the commercial users alike. Both of these user groups have been expanding and the 1984 NODDS Memorandum of Agreement between the two agencies specified a fifty to fifty split in the use of the computer resources.

Since 1983, this 50/50 split between DOD and non-DOD use of the resources has never been achieved. However, this has not become a problem because none of the users has had a continuing access problem. Currently, the non-DOD users use

nearly 60 percent of the resources and DOD the remaining forty percent. With communication saturation nearing, only a larger host computer and communication interface can fulfill this initial computer resource allocation.

NOAA's responsibility is for the daily management of the system. This is done by contract with Science Application International Corporation (SAIC) of Monterey, CA. SAIC uses two rotating shift resident managers and an answering service to fulfill the 24-hour demands of the system users. This contract resident manager complement may have to be increased to three due to the larger user demands. NOAA has the problem of providing this unclassified information to the public at the lowest possible cost and yet not exceeding the perceived thirty dollar maximum. The current costing algorithm is included in the Appendix. In some respects, the Navy was wise not to deal with the commercial user segment.

In February 1984, a test was conducted in order to transmit, via the International Marine Satellite (INMARSAT), a NODDS product from Monterey, CA. to Washington, D.C. The test was successful, and this opened up the possibility of numerous vessels "at sea" to have direct access to the host PDP 11/60. Of course, the vessels would require the proper INMARSAT equipment and CRT terminals. However, to NOAA, the problem would be how to collect a user fee, in a timely manner, from a vessel at sea. Needless to say, the expansion issue for both the Navy and NOAA poses different problem sets.

IX. FUTURE PLANS

A. GENERAL

Presently the NODDS program suffers from two immediate problems. First, a communications bottleneck exists which allows only five TYMNET users access to the system using the multiprogramming techniques of the host computer. Secondly, the near saturation of the memory space capacity will not allow numerous data files and especially satellite data to be a future product.

The ability of the PDP 11/60 to handle an expanded user environment is crucial. The most recent test using five TYMNET users and three local Dial-Up users proved successful in November 1984. No slowdown of the access time was noted by any user; however, the NODDS Resident Manager could not update or change any of the files. The program works now for the present users, but an access lockout may occur for non-DOD and DOD users alike. Several options now confront this expansion issue.

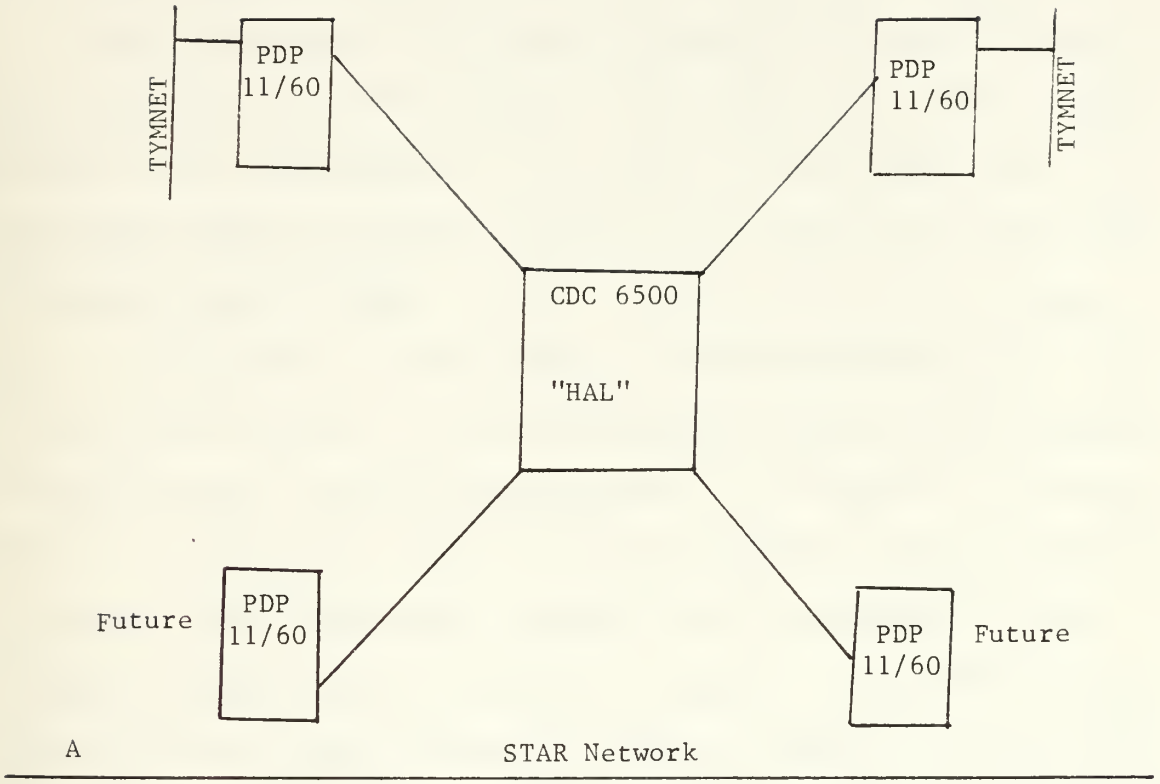
B. THE NO FUNDS OPTION

The no funds option results in a degradation of the system in order to service additional users. The alternative is to deny access to any user; however, this will not be viable for the DOD community. If this be the case, the NODDS

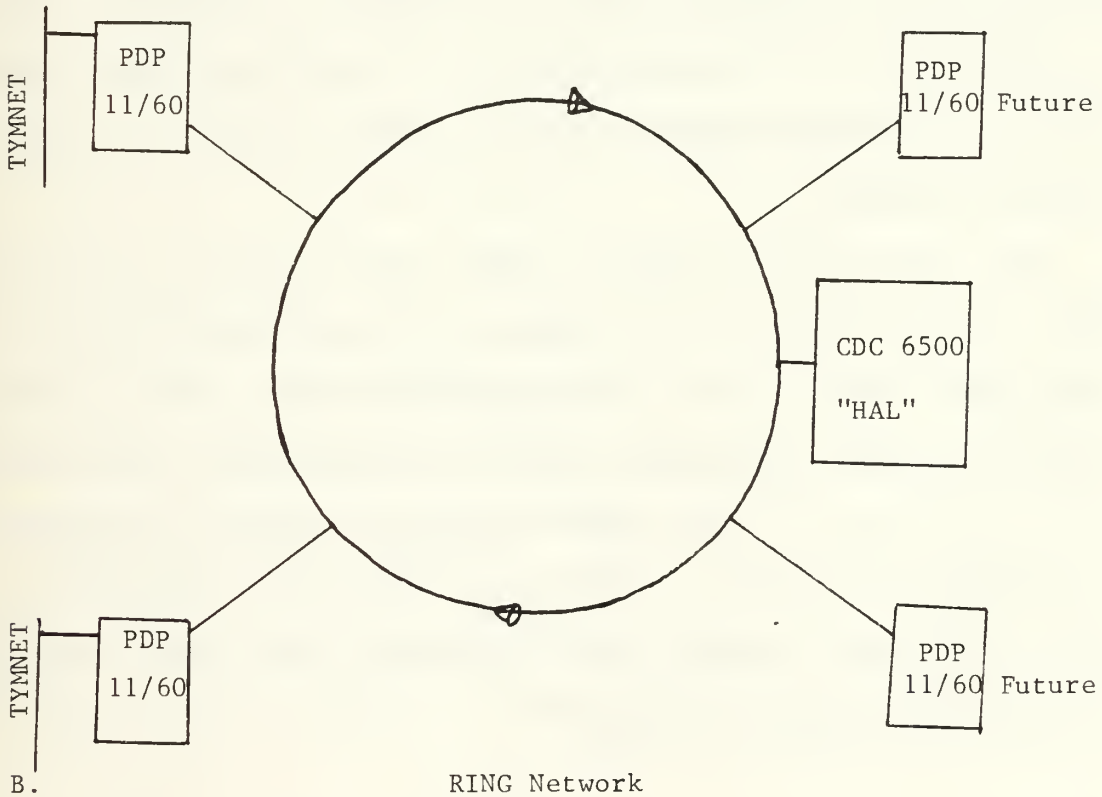
Memorandum of Agreement would be dissolved and the entire system will be again controlled by FNOC, and NODDS would return to a Navy Oceanographic Data Distribution System. The time has arrived for both Navy and NOAA to expand the system from the original Commercial Demonstration Project to a real data distribution system.

C. THE LIMITED FUNDS OPTION

The objective of this option is to best satisfy both the communications bottleneck and to provide some additional memory space at the least possible cost. This objective can be achieved by duplicating the existing TYMNET PDP 11/60 architecture and using the CDC 6500, "Hal", computer as the master in the "ring" or "star" network, as described by Tanenbaum [Ref. 4]. The choice for a PDP 11/60 or other software compatible Digital Equipment Corporation computer would simplify the amount of software exchange for the second system. Figure H indicates these two sub-options. The differences between these two sub-options have been stated by Greene and Pooch [Ref. 5]. The star sub-option has been analyzed by Anderson and Sensen [Ref. 6]. The ring sub-option can have a DECNET type architecture [Ref. 7]. Current plans are for FNOC to replace the PDP 11/60 with a much faster PDP 11/70 in July/August 1985. The ring and star sub-options could be used with PDP 11/70 computers.



A STAR Network



B. RING Network

Sub-Options For Expansion

Figure H

This duplication has several advantages besides the easy implementation of the system software. The idential but separate hosts provides for a separate DOD and non-DOD access for products and data. This in turn allows for a more accurate definition of a true "user fee" and allows the DOD community to implement the Data Defense Network (DDN) at some future date. Since the inception of DDN in April 1982 [Ref. 8], its implementation seemed dependent upon its complex inter-net capability. TYMNET is currently serving both the DOD and non-DOD access requirements for the NODDS Program.

The disadvantages are: first, additional work will be required to update, change, or delete two different systems resulting in a probable second resident manager during normal working hours. Secondly, the user fee will probably increase to about double the current rate. The most important effect will be on the maintenance costs for two fifteen to twenty year old systems.

The cost of duplicating the PDP 11/60 system is relatively small. The current resale market has a PDP 11/60 or 11/70 system for about 20 to 25 thousand dollars [Ref. 9]. Installation and software exchange could be accomplished for another 5 to 8 thousand and the TYMNET connection would add another 5 thousand to the total costs. The end result would be to provide a modest expansion for the one to two year time frame, for under 50 thousand dollars.

D. LONG TERM OPTION

While the "ring" and "star" sub-options are suitable for meeting the near term needs of the program, the maintenance costs can be significant. The PDP 11/60 is essentially an old but reliable machine; however, it should be replaced by much newer technology.

By returning to the original CDC 6500 computer, "Hal", and its existing link to the PDP 11/60, and by replacing the PDP with a much larger system; most of the long term problems can be solved. Again, the replacement system should be software compatible with the PDP and have a large enough memory capacity to store future (three to five years) satellite data to be used by various users. Such a system exists. A VAX 11/780 VMS system with 96 communication port capability and expandable memory to 16 mega bytes would serve NODDS current and future needs. The estimated unclassified satellite data that users would want access to within the next five years is estimated to be about 1 mega byte per day. The most current GEOSAT data is expected to deliver 186K, 60 byte words per day. Within the next five years, there might be up to six unclassified satellite data bases that the NODDS program may deliver to the various users.

The 1984 cost of such a system is about 750 thousand dollars [Ref. 10], complete with at least 2 mega bytes capacity of memory and at least 16, expandable to 96 communications

ports. With such a system, both Navy and NOAA products, data and satellite readouts may be accessed by both DOD and non-DOD users alike. Again the effect of acquiring this system would at least triple the current user fee and all the small time users would be priced off the system. Another effect is that the NODDS Resident Manager may or may not have to be increased; however, some retraining will be required.

X. RECOMMENDATION

The basic concept of this analysis has been to document the past growth pattern of the initial SDDS program and to show the extent of the expansion mode especially since late 1983. This expansion has been manifested in terms of products, data, and new users. A new NODDS user conference may provide some insight as to the near term requirements of these expansion elements.

Three factors have the potential for requiring the system to expand its hardware capability within the next twelve months. For the non-DOD user group, the availability of new models and new unclassified satellite data will require more communications ports and larger mass storage. For the DOD user group, the proliferation of Zenith Z120 terminals and the existence of Zenith emulators for NODDS graphics will potentially saturate the TYMNET communication interface and the host computer. Lastly, the ability of the INMARSAT satellite to transmit any NODDS product will open up an entirely new maritime user group. All these factors will result in more coordination between the FNOC computer operators and the NODDS Resident Managers. In order to satisfy both the DOD and non-DOD users, the longest complaint has been late products. This situation will have to be dealt with in the near future.

Being a jointly managed program, neither Navy or NOAA should have to fund an expansion effort alone. The funding available will dictate which option will be chosen. However, in order to avoid degradation of the existing system, an option must be selected. If joint funding can be arranged, option C, a DEC 11/780 VAX computer, even if leased, would be the most long term, cost effective solution to these problems.

APPENDIX

ACRONYMS

COMSAT	-	Communications Satellite Corp.
DOD	-	Department of Defense
ERT	-	Environmental Resource and Technology, Inc.
FNOC	-	Fleet Numerical Oceanography Center
INMARSAT	-	International Marine Satellite
JPL	-	Jet Propulsion Laboratory
NASA	-	National Aeronautics and Space Administration
NOAA	-	National Oceanic and Atmospheric Administration
NODDS	-	1982 - 1983 Navy Oceanographic Data Distribution System 1983 - Present Navy/NOAA Oceanographic Data Distribution System
ODSI	-	Ocean Data Systems, Inc.
OPARS	-	Optimum Path Aircraft Routing System
SAIC	-	Science Applications International Corp.
SDDS	-	Seasat Data Distribution System
SOWM	-	Spectral Ocean Wave Model

MEMORANDUM
OF
AGREEMENT

1. Background and Introduction

The Navy Oceanographic Data Distribution System (NODDS) evolved from the NASA Satellite Data Distribution System (SDDS) located in Fleet Numerical Oceanography Center (FLENUMOCEANCEN) facilities from 1978-1982. The SDDS was used to provide access to, and distribution of, unclassified Navy oceanographic and atmospheric products and data to civil sector and non-Department of Defense (DOD) governmental users. Upon completion of the SDDS project in 1982, the NASA owned Digital Equipment Corporation (DEC) PDP 11/60 computer used by the project was transferred to the Navy (FLENUMOCEANCEN) for use with the newly established NODDS program.

On 1 July 1983, through unwritten mutual agreement, NODDS became a joint data and product distribution program between the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce and the Navy. This Memorandum of Agreement will define the role of each participant in the operation of the NODDS program.

2. Discussion

NODDS uses a DEC PDP 11/60 computer to process, format, store and transmit NODDS products and data to both government

and non-government (commercial) users. The DEC PDP 11/60 files are used to store unclassified products and data and the users may call "on-demand" for the products they wish to receive from the files. The on-site management of NODDS is contracted out on a 24-hour per day basis, with the contractor-provided manager being "on-call" after normal working hours.

Upon acceptance of this Memorandum of Agreement by both parties, the name of the system will be known as the Navy/ NOAA Oceanographic Data Distribution System (NODDS).

3. Basic Responsibilities

a. The Navy will supply specified unclassified data and products from the FLENUMOCEANCEN operational computer run. The delivery of this information will be accomplished on a not-to-interfere basis with the operational requirements of FLENUMOCEANCEN. The Navy will endeavor to reserve 50% of the NODDS capacity for use by NOAA and NOAA supported users. Navy shall also:

(1) Provide, on a not-to-interfere basis, a computer system analyst to perform NODDS system software maintenance as required.

(2) Provide access to the NODDS via the TYMNET engine installed at FLENUMOCEANCEN and via 4800 baud direct access dial up MODEMs.

(3) Provide space and utilities, excluding telephone service, for the individual performing duties as the NODDS on-site manager.

(4) Provide DEC PDP 11/60 computer maintenance and repairs as required.

b. NOAA shall provide for the on-site management of NODDS. In this effort, NOAA shall also compute and collect from civilian subscribers any costs associated with providing civil sector and non-DOD governmental support through NODDS. NOAA shall also:

(1) Provide for 24-hour per day user interface management of NODDS.

(2) Establish and collect appropriate user fees for non-DOD U.S. government users of NODDS.

c. Either party may, at any time, reduce or curtail this system as the situation warrants.

4. Period of Agreement

This agreement shall become effective upon its signature by both parties and shall remain in effect until 31 December 1984 (or earlier agreed date) at which time it will be renegotiated.

5. Modification and Termination

This agreement sets forth the entire understanding between the Navy and NOAA concerning the NODDS program. This agreement may be terminated prior to its expiration by written notice to the other party not less than 30 days in advance or in cases of National Emergency as the circumstances warrant.

Paul M Wolff 4/6/84

PAUL M. WOLFF Date
Assistant Administrator for
Ocean Services and Coastal
Zone Management, NOAA

3/1/84

L. J. PINGEL Date
Captain, U.S. Navy
Commander
Naval Oceanography Command

Memorandum of Understanding
between the
Naval Oceanography Command
and the
National Ocean Service,
National Oceanic and Atmospheric Administration
on the cooperative relationship between
Fleet Numerical Oceanography Center and
the National Ocean Service

1. General Information

The Department of the Navy and the National Oceanic and Atmospheric Administration (NOAA), Department of Commerce, have agreed in a basic Memorandum of Agreement dated 3 May 1982 to share efforts in the field of ocean prediction services. To facilitate this sharing, it is necessary that the National Ocean Service (NOS) of NOAA maintain a presence at the primary Navy center for ocean prediction, the Fleet Numerical Oceanography Center (FNOC), a unit of the Naval Oceanography Command (NOC). The purpose of this presence is to facilitate the exchange of scientific information, coordinate the development and operation of ocean predictive services, and coordinate the sharing and dissemination of raw and processed data.

2. Background

In order to obtain sufficient data to carry out their missions, both NOC and NOS support such programs as the observation of oceanographic parameters, maintenance of data

files of those parameters, research on ocean climatology and the development/comparisons of various numerical models which analyze and predict oceanographic conditions.

Since 1979, NOS and the Naval Oceanography Command have supported the Cooperative Oceanographic Observation Program (COOP), a joint effort to increase the number of bathythermograph observations in the world's oceans, managed by FNOC.

In an effort toward mutual cooperation in these areas, a NOAA Liaison Officer was assigned at FNOC in July 1983. Since this billet was established, a data link between FNOC and the National Meteorological Center (NMC) of NOAA has become operational. Currently over 200 products are exchanged daily between the centers. Also, the dissemination by NOS of FNOC produced data to end users has been expanded. This expansion includes data dissemination both to other government agencies and to the commercial sector through the NOAA-managed Navy/NOAA Oceanographic Data Distribution System (NODDS) located at FNOC. Future areas of collaboration include the cooperative development of new oceanographic models and the improvement of data base quality.

3. Purpose

The terms of this agreement are set forth in order to support the continuing exchange of data, technology, products and information between NOC and NOS. By this memorandum,

the Navy and NOS agree to continue to support and expand these mutual efforts.

This document defines the responsibilities of the agencies concerned. Specific arrangements between local commands providing support shall be subject to the guidance of this agreement.

4. Responsibilities of Participating Organizations

The Navy, through the Fleet Numerical Oceanography Center, and the National Ocean Service, through a support service group at FNOC, will provide for the following functions. Each agency will reimburse the other for costs incurred as set forth in section 6 of this MOU.

A. National Ocean Service will:

(1) manage the Navy/NOAA Oceanographic Data Distribution System including all interfacing with civil and non-DOD users of the system;

(2) coordinate NOAA participation in the COOP and provide an automated system for quality control of incoming bathythermograph data on a quasi-real-time (5 day/week, 1 shift) basis;

(3) assist in the development and improvement of models and computer programs for ocean data assimilation and;

(4) maintain sufficient personnel at FNOC to enhance product/data exchange, model improvement, product evaluation, and backup capability of each agency;

(5) by separate agreement, fund construction for NOAA dedicated space in a building to be constructed at FNOC in Military Construction Project P-004.

B. Navy will:

(1) provide all unclassified data available at FNOC, raw and processed, to NOAA. Delivery will be to the NODDS, or by data link to the Joint Ocean Prediction Center, National Meteorological Center, Washington, D.C. Classified bathythermograph data will be declassified and made available to NOAA at the earliest time consistent with national security;

(2) provide on-site NOAA personnel access to specialized oceanographic software, unclassified data files and computer resources as needed to carry out agreed upon functions;

(3) provide up to 50% of the capacity of a PDP-11/60 computer and associated peripheral and communications equipment to serve NODDS users;

(4) provide temporary office space, including usual utilities and maintenance service, for on-site NOAA personnel until the NOAA-funded spaces in Military Construction Project P-004 are completed (see paragraph 6).

C. Both parties will provide access to personnel for consulting services for improvement of data acquisition and ocean prediction.

5. Other Provisions

Nothing herein is intended to conflict with current NOAA or Navy directives. If any of the terms of this agreement are inconsistent with existing directives of either of the agencies entering into this agreement, then those portions which are determined to be inconsistent shall be invalid; but the remaining terms and conditions of this agreement not affected by any inconsistency shall remain in full force and effect.

6. Programming, Budgeting, Funding and Reimbursement Arrangements

Within the terms of this agreement, budgeting, funding and reimbursements will be accomplished by the respective agencies in accordance with the fiscal responsibilities indicated herein. An annual funding plan will be prepared by the Commanding Officer, FNOC and the Senior NOS official on-site at FNOC. Each agency will be reimbursed for out-of-pocket costs related to providing services to the other agency, which would not have been otherwise incurred. Charges for computer resources will be as prescribed in the current FNOC ADP resource charge policy for government users.

7. Amendments and Review

This agreement may be amended at any time by mutual consent of the agencies concerned. This agreement will be reviewed periodically, but not less than annually, and is subject to reconsiderations at such times as may be required and agreed to by the parties entering into this agreement.

APPROVED

_____ (date)	_____ (date)
CAPT JAMES E. KOEHR, U.S. Navy Commander Naval Oceanography Command	MR. PAUL M. WOLFF Associate Administrator National Ocean Service, NOAA

NAVY/NOAA OCEANOGRAPHIC DATA DISTRIBUTION SYSTEM
(NODDS)

USER AGREEMENT

This user agreement, entered into by the National Oceanic and Atmospheric Administration, an element of the United States Department of Commerce acting under the authority of title 31, U.S. Code 483A, and _____, a company/ corporation organized under the laws of _____.

WITNESSETH:

WHEREAS, The U.S. Navy's Fleet Numerical Oceanography Center is able to provide, on a not to interfere basis, certain marine environmental data and products to The National Oceanic and Atmospheric Administration (NOAA), and

WHEREAS, NOAA is required to provide such marine environmental data and products at no additional cost to the government, and

WHEREAS, _____ expects to pay a fair and equitable fee for these products and data, and

WHEREAS, it is understood that this agreement is not exclusive in character but is similar to Agreements for NODDS data and products with other users and organizations,

NOW THEREFORE, the parties to this agreement do hereby declare their understanding as follows:

1. Basic Responsibilities of the Parties

A. NOAA will exercise its best efforts to supply to _____ certain agreed upon data and products from the NODDS.

B. The _____ will utilize the NODDS derived data and products in the conduct of its normal business operations and normal business practices.

2. Period of Agreement

This Agreement shall become effective upon its execution by the authorized representatives of the Parties and shall remain in effect until 31 December 1984 (or earlier agreed date).

3. Payments

The _____ agrees to reimburse the United States Government for all data and products derived from the NODDS at the rate of ten dollars and sixty-five cents ($10.65) per connect hour, or at an adjusted rate as determined semi-annually by NOAA. Non-payment of these user fees after 30 day receipt of the quarterly billing may result in discontinuation of a users access to NODDS products and data.

4. Government Property

No government property shall be supplied to _____ as part of this agreement.

5. Party Representatives

The authorized _____ representative and point of contact for the above purposes will be _____ Title . The authorized NOAA representative will be CDR. Paul M. Duernberger, NOAA.

6. Resident Manager

The point of contact for NODDS operational matters will be the on-site NODDS duty manager.

7. Liability

NOAA will make all reasonable efforts to ensure the continuity, quality, reliability and accuracy of data and products supplied to _____, but does not make

any warranty regarding such data or products or the results of their use, and neither NOAA nor any of its contractors will be liable to _____, nor any third parties for any harm arising from the _____, failure to receive, or its use of the data or products to be supplied under this Agreement.

NODDS COMMERCIAL USER FEE

effective 1 Apr. 1985

TOTAL TYMNET HOURS/MONTH

1/84	1507.6
2/84	1549.5
3/84	1866.8
4/84	1739.7
5/84	1580.8
6/84	1420.8
7/84	1450.8
8/84	1594.8
9/84	1407.2
10/84	1451.9
11/84	1151.6
12/84	1194.2
Total	17915.7

Total (7/84-12/84) 8250.5 (six month total)
Total (10/84-12/84) 3797.7 (three month total)

NODDS CONNECT HOURS/MONTH

Month	Commercial Tymnet	Commercial Non-Tymnet	Total Commercial
Jan. 84	111	160	271
Feb.	153	260	413
Mar.	126	233	359
Apr.	144	231	375
May	130	222	352
Jun.	130	178	308
Jul.	129	171	300
Aug.	121	181	302
Sept.	149	174	323
Oct.	48	139	187
Nov.	36	139	175
Dec.	33	133	166
Totals	1310	2221	3531
yearly avg.	109	185	294
last six months	86	156	242
last three months	39	137	176

TOTAL NODDS CONNECT HOURS (DOD, Other GOV'T, Commercial)

Month	Hours
Jan. 84	632
Feb.	872
Mar.	815
Apr.	604
May	788
Jun.	692
Jul.	725
Aug.	748
Sept.	681
Oct.	478
Nov.	547
Dec.	491
Total	8073

yearly avg.	673
last six months	611
last three months	505

TOTAL TYMNET COSTS TO FNOC PER MONTH

Jan. 84	16,062.19
Feb.	16,508.91
Mar.	18,341.58
Apr.	17,091.58
May	17,182.79
Jun.	16,371.65
Jul.	15,727.44
Aug.	17,467.91
Sept.	15,973.75
Oct.	17,740.34
Nov.	15,514.65
Dec.	13,683.40
Total	197,666.19

yearly avg.	16,472.18
last six months	16,017.15
last three months	15,646.13

Fixed FNOC Tymnet costs not applicable to NODDS Commercial Users- $3,311.51 per month.

yearly avg. (16,472.18) - FNOC Fixed costs (3,311.51) = 13,160.67
Last 6 months (16,017.15) " " = 12,705.64
Last 3 months (15,646.13) " " = 12,334.62

NODDS COMMERCIAL TYMNET COSTS

yearly avg.	13,160.67	x	109 / 1492.9	=	960.89
6 Month avg.	12,705.64	x	86 / 1375.0	=	794.68
3 Month avg.	12,334.62	x	39 / 1265.9	=	380.00

NODDS NOAA/SAI COSTS

Resident Mgr.	5,400	
JPL Overhead	540	
Ans. Service	200	
Equip. (New Terminal)	10	
SAI Overhead	516	
	6,666	per month

NODDS FNOC COSTS

Tech Support	420
PDP 11/60 Maint	200
FNOC Mainframe	650
PDP Connect Fee	450
Assessed Use	50
Admin Surcharge	140
Total	1910

Yearly avg. costs/mth	960.89	+	1910.00	+	666.00	=	9536.89
Six Month avg. costs/mth	794.68	+	"	+	"	=	9370.68
3 Month avg. costs/mth	380.00	+	"	+	"	=	8956.00
Commercial Non-Tymnet users only pay	6666.00	=	1910.00			=	8576.00

User Fee Calculations:

Yearly Average:

Commercial Tymnet Users,

$$9536.89 \times \frac{109}{673} \times \frac{1}{109} = 14.17 \text{ per hr.}$$

Commercial Non-Tymnet:

$$8576.00 \times \frac{185}{673} \times \frac{1}{185} = 12.74 \text{ per hr.}$$

Yearly Fair Share Calculations:

$$\frac{109}{294} = .370 \times 14.17 = 5.24 \text{ (Commercial Tymnet User)}$$

$$\frac{185}{294} = .630 \times 12.74 = 8.02 \text{ (Commercial non-Tymnet)}$$

13.26 Yearly avg. User Fee

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